

# Two Sides of the Same Coin? – The Effects of Hierarchy Inside and Outside Enterprise Social Networks

*Completed Research Paper*

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## Abstract

*With more companies using Enterprise Social Networks (ESN) for employee communication and collaboration, the influence of ESN on organizational hierarchies has been subject of discussions in science and practice. Conversely, the question if formal hierarchies affect interaction inside ESN and outside (i.e., personal interaction or interaction via traditional media) in the same way has not yet been addressed. The aim of our research is to analyse those hierarchical effects. By contrasting a rich dataset comprising two years of communication and collaboration inside an ESN with data from an online survey, we found significant differences between the hierarchical effects inside and outside the ESN and their impact on communication and collaboration. Although our findings indicate significant impact of formal hierarchy, we found it to be weaker inside the ESN. We conclude that interaction inside ESN is more inclusive and balanced across hierarchical levels.*

**Keywords:** Enterprise Social Networking, Hierarchies, Communication, Collaboration

## Introduction

Recently, Enterprise Social Networks (ESN) have been playing an increasingly crucial role for organizations when it comes to online communication and collaboration (Aral et al. 2013; Kane 2015; Kane et al. 2014). ESN are online platforms with functionalities to support employees in expert finding, ideation, or team coordination (Guy et al. 2013; Richter et al. 2011b). ESN have proven successful to improve corporation-wide information seeking and knowledge sharing without being subject to departmental and geographic boundaries (Cetto et al. 2016; Oostervink et al. 2016; Steinhueser et al. 2015; von Krogh 2012).

These communication and collaboration activities are formalized to a certain degree, depending on the type of organization. In a bureaucratic/orthodox organization the chain of command can be very strict, in a network organization formal functions emerge due to the given tasks (Diefenbach and Sillince 2011). In either case, formal organizational hierarchy is an essential and pervasive organizational characteristic

(Diefenbach and Sillince 2011; March and Simon 1958; Penrose 1959; Thompson 1967). The official structures, allocated by formal roles and ranking positions, heavily influence social relations and the resulting network structures (Corominas-Murtra et al. 2013; West et al. 1999) and therefore the way employees communicate and collaborate.

When it comes to digital media, with ESN being a prominent example, the interplay of formal organizational hierarchies and users' communication and collaboration behaviour is still widely unexplored. A number of studies emphasize the importance to better understand the role of formal hierarchies in ESN (Howison et al. 2011; Kane et al. 2014) as ESN seem to have the potential to change organizational network structures (Chau and Xu 2012; Trier and Richter 2015). Only if we have a clear and comprehensible picture of the role of hierarchy as dependent and independent variable of ESN use, we can deploy them to transform the ways we work and relate to each other.

In order to contribute to this comprehensible picture, we explore the effect of organizational hierarchy on employees' interaction. When referring to interaction, we differentiate between communication (exchanging messages within a network of interdependent relationships (Goldhaber and Barnett 1988; Goldhaber 1993) and collaboration (planning and executing a shared project towards a common goal based on shared resources or objects (Hord 1986). More specifically, we do not only research the effects of hierarchies on employees' interaction inside an ESN but also the hierarchical effects on employees' interaction outside an ESN. Here, interaction outside ESN comprises all kinds of professional interaction that is done personally or via the use of traditional media such as telephone or email between two or more persons. Doing so allows us to draw conclusions about the effect of ESN compared to other media. Thus, our research question is as follows: *What are the effects of formal hierarchies on employees' interaction inside and outside an ESN?*

Our results contribute to existing research in various ways: First of all, we show that formal hierarchy strongly affects interaction inside and outside ESN. For instance, our results reveal that users tend to communicate with individuals on the same hierarchical level. More importantly, our study is the first to show that the effect of hierarchy on communication and collaboration differs between inside ESN and outside ESN in several aspects. We do not only find a weaker effect of hierarchies on communication and collaboration in ESN, but are also able to show that the chain of command is erupted in ESN.

These findings have important implications for theory and practice. They contribute to a better theoretical understanding of the role of ESN in the communication repertoire of employees. More specifically, they show how communication and collaboration behaviour inside and outside ESN differ with respect to the influence of formal organizational hierarchy. From a managerial perspective, our results are also of interest for organizations that use ESN to foster collaboration across hierarchies. Communicating and collaborating across different hierarchical levels means using the full potential of the existing organisational knowledge (von Krogh 2012). Our study gives people responsible for implementing ESN in organizations insights into how ESN impact the formal relations and thus, the communication patterns across the organizations. For instance, ESN can facilitate the participation from all hierarchical levels during the creation of new innovations and thus support business transformations.

The remainder of this paper is structured as follows: In the next section, we provide an overview of the relevant literature on organizational hierarchies and structures, the interplay of formal organizational hierarchy and IS in general and ESN in particular. The third section describes the research method, the case setting, the data collection, as well as the analysis process. In the fourth section, we present the findings of our analysis, i.e. differences in the effects of hierarchies inside and outside the ESN and the impact of hierarchies on employees' interaction. Afterwards, we discuss implications of our research for theory and practice. We also reflect on the limitations of our work and provide directions for further research. A brief summary concludes our study.

## **Theoretical Foundations**

To lay the theoretical basis for our study, we discuss direct and indirect effects of formal hierarchy on various aspects of interaction in offline and online settings. We furthermore show how the aspect of hierarchy has been analysed in the context of IS in general and ESN in particular.

## **Organizational Hierarchies and Structures**

Formal hierarchy has a long history in organizational research. Max Weber describes hierarchy as a “vertical formal integration of official positions within one explicit organizational structure” (Weber and Roth 2007). This view is in line with conceptualisations and definitions from a number of organization and management scholars (March and Simon 1958; Penrose 1959; Thompson 1967). Recently, Putzke et al. (Putzke et al. 2010, p. 3) summarized that “in today’s use, hierarchy is defined as any ordered set of entities that can be classified as being inferior, superior or on the same level as one other”. Thus, in an organization with a well-marked formal hierarchy “each position or office is under the control and supervision of a higher one” (Diefenbach and Sillince 2011). Therefore, all roles and positions within the hierarchical structure are unambiguously defined and enable a clear differentiation between each other (Zeitlin 1974). Social groups contain different types of power which in turn can establish hierarchical structures (French and Raven 1959).

Formal decision-making structures, whether in terms of “authority”, “command”, or “control”, are integral features within modern organizations (Marcum et al. 2012). In an organizational hierarchy, individuals act under a regime of administrative procedures and job roles defined by higher level superiors (Powell 1990; Putzke et al. 2010). Hence, formal hierarchy is an essential and also pervasive organizational characteristic (Corominas-Murtra et al. 2013), which is represented in formal relations, for example an “org chart” in organizations. According to Diefenbach and Sillince (2011), different types of hierarchical organizations can be distinguished by how strict the chain of order is regulated. Here, in a *bureaucratic/orthodox organization* all roles are placed along a given line of top-down control, where orders are transmitted downwards. In contrast, in a *network organization* the hierarchy is ordered via the emergence of formal functions due to given tasks and not a strict chain of command.

Next to these formal relations, employees also establish different types of informal relations which can be distinguished into four types, namely: similarities (i.e., two persons sharing similar characteristics such as location or gender), social relations (i.e., the kind of relation between two persons such as kinship or affection), interaction (i.e., the kind of interaction that invoked the relation between two persons such as communication or collaboration), and flows (i.e., the kind of “good” that is transferred from one person to another such as information or resources) (Borgatti et al. 2009). Existing formal structures heavily influence these informal structures (West et al. 1999) and hence limit the variety of future informal network structures (Corominas-Murtra et al. 2013). The effect of hierarchy on social relations was evaluated for example in British hospitals among groups of doctors and nurses. The results show that nurses are more likely to discuss important matters with juniors than with doctors and hence form a distinct network structure (West et al. 1999). These network structures in turn have an influence on information dissemination (Chau and Xu 2012), contribution behaviour (Zhang and Wang 2012), employee performance (Wu 2013; Zhang and Wang 2012), and stability of organizational networks (Quintane et al. 2013).

Both, organizations with a well-marked formal hierarchy and organizations with a less marked formal hierarchy, have their own strengths and weaknesses. The strength of well-marked hierarchical organizations lies in their reliability, they are best suited for producing large quantities of standardized products or services (Powell 1990). Hence, organizations with mechanistic structures, that is organizations with a well-marked formal hierarchy, are most appropriate under conditions of high task certainty (Tichy et al. 1979). Today, companies are facing greater uncertainty due to technological changes, knowledge intense tasks, and higher performance expectations. With increasing uncertainty, hierarchy is only exceptionally employed since the number of exceptions increases until hierarchy becomes overloaded (Galbraith 1974). The aspect of information sharing illustrates the differences between network and hierarchy. When information is passed along the formal hierarchy, new meanings or interpretations are only rarely generated. Formal hierarchy only structures the flow of information (Johnson et al. 1994). In contrast, as information passes through a network, new connections and meanings are generated and evaluated (Powell 1990). Hence, network forms of organizations seem better suited for knowledge workers who possess fungible knowledge that is not limited to a specific task but applicable to a wide range of activities (Powell 1990).

## ***Hierarchies and Enterprise Social Networks***

There are only few studies that investigate the interplay of formal organizational hierarchy and IS in general and ESN in particular. Nevertheless, it is indicated that IS usage influences company culture and consequently hierarchical structures (Leidner and Kayworth 2006). Within this strand of research, scholars focus on the role of hierarchy in computer-supported communication. Here different approaches have been applied (cf. e.g., Rowe et al. 2007; Shetty and Adibi 2005). In this context, Wang et al. (2013) for instance, propose an algorithm called HumanRank that, based on the idea of Google's PageRank, allows to assess the formal hierarchical position of a person based on his or her communication interactions. Other research with respect to the dissemination of information found that discussions are more likely to diffuse vertically up and down the organizational hierarchy, but news is more likely to diffuse laterally as well as vertically, regardless of organizational roles and their connections (Aral et al. 2007).

In the last years, both research and practice have argued that many hierarchical organizations may be transformed into more networked patterns or flatter hierarchies (McAfee 2009; Tapscott and Williams 2006). This transformation is supported and accelerated by new IS such as ESN, which provide opportunities to improve communication and collaboration within organizational boundaries. ESN transfer concepts of social network sites, like uniquely identifiable user profiles or the consume, produce, and interaction with streams of user generated data (cf. boyd and Ellison 2007; Ellison and boyd 2013), in the organizational context. They 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 et al. 2010). Examples of ESN platforms are Microsoft Yammer, IBM Connections, Tibbr or Jive SBS. An important reason for organizations to adopt dedicated workplace ESN services is to mitigate the risk related to confidentiality and information security of using public social networks such as Facebook for workplace communication (DiMicco et al. 2008).

ESN are said to transform power relations and hierarchies (Bobsin and Hoppen 2013) and to have the potential to let all employees interact as equals (McAfee 2009). However, the effect of organizational hierarchies on social networking behaviour in ESN has received only little attention so far. On the one hand, persons from different hierarchical levels employ ESN in different ways and hierarchical structures (with their role-typical behaviour) are reproduced on such platforms (Riemer and Richter 2010). On the other hand, ESN can enable new social structures and thus alter the notion of hierarchy (Bobsin and Hoppen 2013) and increase the visibility of other users' involvement, which in turn can affect users' behaviour (Majchrzak et al. 2013), because they allow users to access information resources without contacting or knowing the author. As a consequence, informational hierarchies can be overcome, because informal relationships established through an ESN can reinforce or interfere formal organizational processes based on hierarchy (Behrendt et al. 2015; Ellwardt et al. 2012).

Riemer et al. (2015) are the first and yet only ones to empirically show that in an ESN the influence of hierarchy diminishes over time and the communication becomes more inclusive and balanced across hierarchical levels. Whereas Riemer et al. (2015) only look at data from inside the ESN, our data set allows us to compare the behaviour inside and outside the ESN and draw conclusions about the effects. Thus, our results contribute to a richer picture of the effects of hierarchies in ESN.

## **Research Method**

As it is our aim to analyse the role of formal organizational hierarchies in-depth, we study a case of the medical service unit of the German Armed Forces (GAF), which have a strictly defined and highly transparent hierarchical organizational structure. Using communication and collaboration behaviour as operationalization for interaction behaviour, allows us to investigate the effects of formal hierarchies inside and outside ESN. In order to analyse how formal hierarchies actually affect communication and collaboration, we focus on the hierarchical levels of the respective communication and collaboration partners. We triangulate evidence from multiple sources, i.e. we use both data extracted from the ESN and data from an online survey on employees communication and collaboration behaviour outside the ESN (Yin 2009, 2012). Thus, we get a profound view of interaction inside and outside the ESN and deep insights into the effects of formal organizational hierarchies.

## Case Setting

The GAF can be seen as a classical bureaucratic/orthodox organization in the context of the five typical types of hierarchical organizations as summarized by Diefenbach and Sillince (2011). All positions are placed along official lines of top-down command and control. Formal authority is closely related to the rank of a position, independent of the actual person holding this position (Diefenbach and Sillince 2011). Therefore, our results seem particularly applicable to organizations of this type (i.e., bureaucratic/orthodox organizations).

The unit in focus is the medical service unit which 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 (medical officers and trainee medical officers) is distributed over five hospitals (all major military hospitals in Germany), 37 universities (i.e., all German universities which offer medical studies), and 200 other facilities. The medical service unit is structured according to the formal organizational hierarchies of the GAF (as described in the *Administrative Order on the Position of the Military Superior cf.* (Bundesministerium der Verteidigung 1956): The military hierarchies are divided into seven levels: general, staff officer, captain, lieutenant, non-commissioned officer (NCO), enlisted soldier and civilians. To make our results transferable to non-military organizational settings, we briefly describe each level and try to compare them to common organizational roles (cf. Table 1).

<b>Table 1. Description of the Hierarchical Levels</b>			
<b>Level</b>	<b>Rank</b>	<b>Description</b>	<b>Common organizational role</b>
7	General	Generals are the top management and have authority over all lower levels. Typically, they are not involved in the daily business, but fulfil representative and strategic tasks covering the entire organization.	Board member
6	Staff officer	Staff officers are typically not involved in the daily business but lead divisions. They have authority over all lower levels and coordinate their subordinates by deciding on strategic aspects.	Executive director
5	Captain	Captains are responsible for the management, training and staffing of a business unit or sub-division. They are involved in the daily business in a consulting role and have authority over all lower levels.	Business unit manager
4	Lieutenant	Lieutenants can lead a collection of teams (e.g., a department) and coordinate their subordinates. They have decision-making power to a certain degree.	Manager
3	NCO	Non-commissioned officers (NCOs) can lead small teams and delegate tasks accordingly. They have decision-making power only in their own team.	Team leader
2	Enlisted soldier	Enlisted soldiers have no authority over others.	Employee
1	Civilian	Civilians who are employed by the GAF.	Employee

**Table 1. Description of the Hierarchical Levels**

In 2009, the department decided to implement an ESN, in the following referred to as Med-Net. By introducing Med-Net, the GAF aimed to foster communication, collaboration, and knowledge sharing among its employees since they are geographically spread across Germany.

The main goals of using Med-Net were described in a strategic document that we had access to and are comparable to other ESN implementation projects (Richter et al. 2011a):

1. Fostering knowledge transfer and collaborative learning among staff,
2. Improving the quality of education and the in-service training of new employees,
3. Strengthening the corporate identity and the networking of staff, and
4. Creating a collaborative knowledge base.

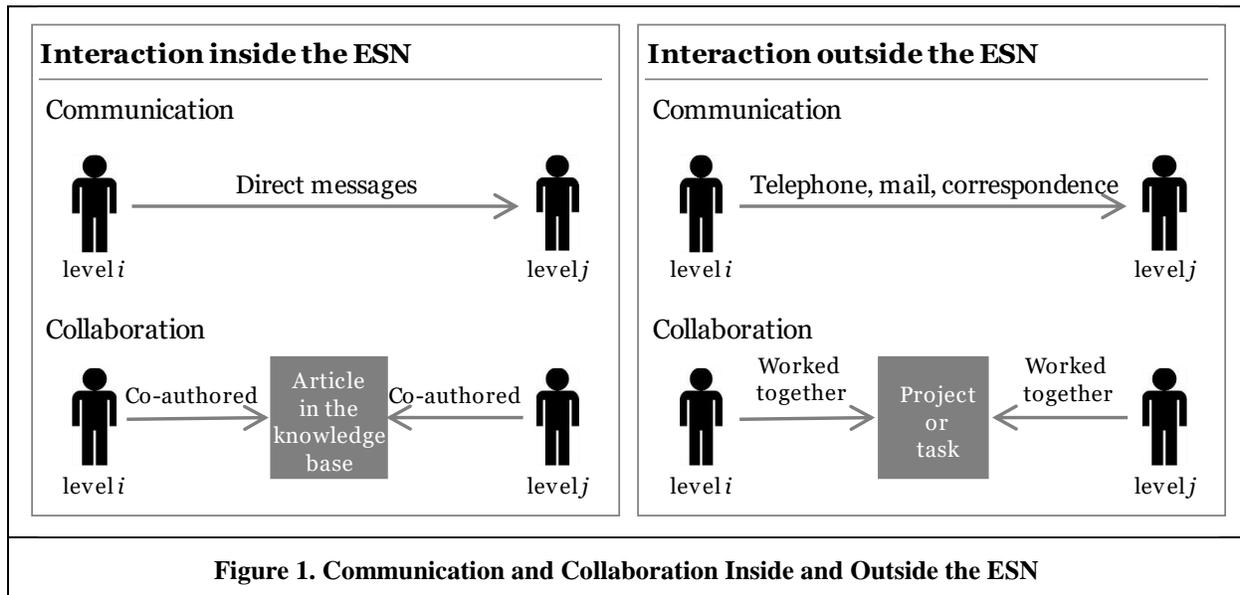
To participate in the ESN, each user has to state his or her real name and military rank. Both are publicly available parts of a user's profile. Hence, each user is aware of the hierarchical level of all other users in the ESN.

Even though the GAF is heavily regulated and has a very complex formal structure, Med-Net does not incorporate any pre-defined structure. Its use is voluntary and the user guidelines allow a self-regulated communication and usage of all features for any purpose. The ESN was launched in November 2010 as a pilot, which was developed and maintained by a research group that one of the authors belongs to. This gave us exclusive access to an otherwise inaccessible dataset.

### Data Collection

To compare the effects of formal hierarchies on interaction inside and outside the ESN, we investigate communication and collaboration behaviour in both settings. Interaction outside the ESN comprises all kinds of professional interaction that is done personally or via traditional media like telephone or email (cf. right-hand side of Figure 1).

To investigate interaction inside the ESN, we refer to respective functionalities in the ESN: Organizational communication can be understood as process of exchanging messages within a network of interdependent relationships (Goldhaber 1993). Against this background, we measured communication inside the ESN by using direct messages that were exchanged between users in the ESN. Collaboration can be conceptualized as organizations or individuals joining forces to plan and execute a shared project towards a common goal based on shared resources or objects (Hord 1986). For this reason, we measured collaboration inside the ESN by analysing which users co-authored articles in the ESN's knowledge base (i.e. a wiki) (cf. left-handed side of Figure 1).



We base on data from two different sources. By conducting an online survey among the employees of the medical service unit of the GAF, we retrieved data about communication and collaboration behaviour outside the ESN. This allows us to draw conclusions about the extent to which people communicate and

collaborate with other people on the different hierarchical levels outside the ESN. Respective data regarding the interaction inside the ESN was ascertained via a dataset exported from Med-Net. Drawing on data from different sources to analyse communication and collaboration outside vs. inside the ESN seems particularly suitable to overcome potential problems of common method bias (cf. Podsakoff et al. 2003).

Basis of our analysis is that the effects of hierarchies can be observed in communication and collaboration behaviour and in consequence, with whom (i.e. hierarchical levels) people communicate or collaborate. To measure the extent of communication and collaboration of a person across hierarchies, we did not only look on who interacted with whom, but also considered the hierarchical level of the involved persons. Thereby, we considered the number of persons on the respective hierarchical levels a person on level  $i$  has actively communicated or collaborated with. This means, to investigate the hierarchical effects on interaction behaviour we focused on a person's number of interaction partners on the respective hierarchical levels. In doing so, we avoided our analysis being biased by increasing amounts of interaction activities, since it is most important with whom a person has interacted with in the time period under observation.

With respect to communication inside the ESN (cf. left-handed side of Figure 1), we looked, for instance, how many persons on each of the hierarchical levels, a person on level  $i$  has written at least one direct message to. Hence, we were able to calculate the distribution of communication partners as well as collaboration partners among the different hierarchical levels.

Summing up, our data allow to draw conclusions on whether the effect of hierarchy inside the ESN is the same as outside the ESN and how hierarchies influence communication and collaboration behaviour inside and outside the ESN.

### ***Data Collection via Online Survey***

In order to understand the effects of hierarchies on interaction in the daily work outside the ESN we employed an online survey. The target group of the survey were members of the medical service unit.

In the questionnaire, we described and explained both kinds of interaction (i.e. communication and collaboration) in detail, to ensure a comprehensive and coherent understanding among the participants of the survey. Here, for instance, we described communication as all professional communication activities that was among colleagues that are conducted personally, or via telephone, mail, or correspondence. Collaboration outside the ESN was described as working together on the same tasks or projects (this includes activities such as writing a joint concept, planning a task incl. resources and time schedule, problem solve on a complex issue). We explicitly told the participants of the survey not to consider interactions in the ESN when answering the questionnaire.

In the questionnaire we asked for an exemplary workweek comprising (please see appendix for concrete questions): 1) the average numbers of persons a person has communicated and collaborated with, respectively, outside the ESN in his or her daily work and 2) the respective distributions of communication partners and collaboration partners among the hierarchical levels.

Thus, we do not only know the number of persons an employee interacted, but also to which extent he or she interacted with persons on the different hierarchical levels. Communication and collaboration behaviour were surveyed for the years 2013 and 2014, respectively. Before the survey was published, it was critically reviewed by a group of researchers as well as members of the medical service unit for reasons of clarity and comprehensibility. Our questionnaire was attached to an online survey commissioned by the administration of the medical service unit. The invitation to the survey was sent via email to all members of the medical service unit. In order to reach out to as many respondents as possible and since the call for participation was only sent out per mail after around four weeks, the administration of the medical service unit decided to run the online survey for 82 days. Moreover, a link to the survey was posted to the cover page of Med-Net after around the same time. Whereas this is a rather long period for a survey, we have no reason to believe that there were timing effects. It was also not possible for a person to re-take the survey. As a result, we were able to collect a sample of 126 complete and valid responses.

The respondents were all employed at the medical service unit. 34% of the respondents indicated they were female, 61% male (5% did not answer the question). 67% declared they were 39 years old and younger, 31% were between 40 and 65 (2% did not answer). Please also note that none of the 126 respondents had a special role related Med-Net like being in charge of the communication unit or being the administrator of

Med-Net. The respondents were mere Med-Net users. Whereas not all participants of the survey have joined the medical service unit prior to 2014 or preferred not to answer to some questions the sample size might differ between the years 2013 and 2014 as well as between communication and collaboration.

Table 2 provides information about the respondents' hierarchical level as well as the share of each hierarchical level in the medical service unit in 2013 and 2014. In addition, it also comprises information about the sample size for communication and collaboration in each year. For instance, 125 persons provided valid responses regarding their communication behaviour in 2014. Since no generals (i.e., level 7) participated in the survey, we do not consider the behaviour of persons on level 7 in our further analysis (Armstrong and Overton 1977).

Hierarchical level	Share of persons in the medical service unit <sup>1</sup>		Number of respondents in the online survey			
			Communication		Collaboration	
	2013	2014	2013	2014	2013	2014
<b>Level 7</b>	0%	0%	0 (0%)	0 (0%)	0 (0%)	0 (0%)
<b>Level 6</b>	13%	14%	46 (43%)	46 (37%)	43 (46%)	44 (41%)
<b>Level 5</b>	7%	7%	5 (5%)	7 (6%)	5 (5%)	5 (4%)
<b>Level 4</b>	3%	3%	27 (25%)	30 (24%)	19 (20%)	23 (21%)
<b>Level 3</b>	36%	38%	22 (20%)	25 (20%)	18 (20%)	20 (19%)
<b>Level 2</b>	11%	13%	1 (1%)	9 (7%)	1 (1%)	7 (7%)
<b>Level 1</b>	30%	25%	7 (6%)	7 (6%)	8 (9%)	8 (8%)
<b>Sum</b>	100%	100%	108 (100%)	125 (100%)	94 (100%)	107 (100%)

**Table 2. Number and Share of Persons and Respondents on the Different Hierarchical Levels**

Based on the information provided by the participants of the survey, for each year and each hierarchical level, respectively, we derived the average distributions of an employee's communication partners and collaboration partners among the hierarchical levels. Hence, we can for instance state, to what extent a person on level 4 on average communicated outside the ESN with persons on the same hierarchical level (i.e., level 4), or on the next higher hierarchical level (i.e. level 5), or with persons on any other level of the organizational hierarchy in 2014. These distributions were calculated on average for each hierarchical level, respectively.

### ***Data Collection via Log File from Med-Net***

To be able to analyse the effects of hierarchies on interaction inside the ESN, the medical service unit of the GAF provided us with a dataset ranging from January 2013 to December 2014 that was extracted from Med-Net. This allowed us to investigate users' interaction behaviour without exerting any control on the ESN and its users. To ensure confidentiality, all personal information (e.g., user names) was removed during data export. The dataset contains, amongst others, information regarding 3,273 unique Med-Net users including their military hierarchical level, direct messages exchanged with other users as well as written, modified, and read articles in the knowledge base.

We used the direct messages to represent communication in the ESN. For our research, we can draw on 942 direct messages written in 2013 and 2014 to represent communication inside the ESN. As prior mentioned, we used the knowledge base that can be considered as a wiki to investigate collaboration inside the ESN. Therefore, we assume that two users of the ESN collaborated if they co-authored the same article

<sup>1</sup> Due to confidentiality and on behalf of the administration of the GAF, we are not allowed to provide information on the absolute number of persons on each hierarchical level.

in the knowledge base. In the knowledge base a total of 485 articles were authored and 752 modifications were undertaken in the time period under observation. Summing up, we analyse users' communication in terms of direct messages sent to other users and collaboration in terms of working together on articles in the knowledge base in the time period under observation.

Depending on the hierarchical level, Table 3 shows the number and share of users in the ESN as well as the respective sample sizes for communication and collaboration inside the ESN for the years 2013 and 2014. On this basis, for each year and each hierarchical level, respectively, we calculated the average distributions of an employee's communication partners and collaboration partners among the hierarchical levels – i.e., to what extent users on a specific hierarchical level on average interacted with other users in the ESN depending on the hierarchical levels.

<b>Table 3. Number and Share of ESN Users on the Different Hierarchical Levels</b>						
<b>Hierarchical level</b>	<b>Number of unique users in the ESN</b>		<b>Number of users included in our dataset (sample)</b>			
	<b>2013</b>	<b>2014</b>	<b>Communication</b>		<b>Collaboration</b>	
			<b>2013</b>	<b>2014</b>	<b>2013</b>	<b>2014</b>
<b>Level 7</b>	7 (0%)	8 (0%)	2 (1%)	3 (1%)	0 (0%)	1 (1%)
<b>Level 6</b>	278 (16%)	686 (24%)	62 (16%)	84 (16%)	23 (15%)	27 (29%)
<b>Level 5</b>	171 (10%)	239 (8%)	41 (10%)	40 (8%)	18 (12%)	12 (13%)
<b>Level 4</b>	699 (39%)	761 (27%)	173 (44%)	188 (37%)	78 (51%)	34 (36%)
<b>Level 3</b>	438 (24%)	616 (21%)	88 (22%)	127 (25%)	24 (16%)	11 (12%)
<b>Level 2</b>	86 (5%)	316 (11%)	10 (3%)	29 (5%)	1 (1%)	0 (0%)
<b>Level 1</b>	116 (6%)	257 (9%)	15 (4%)	41 (8%)	8 (5%)	9 (9%)
<b>Sum</b>	1,795	2,883	391 (100%)	512 (100%)	152 (100%)	94 (100%)

**Table 3. Number and Share of ESN Users on the Different Hierarchical Levels**

## Results

This section is dedicated to the findings of our study. First, we analyse whether the effects of hierarchies on communication and collaboration generally differ inside and outside the ESN. Then, we focus on how hierarchies influence communication and collaboration behaviour inside and outside the ESN.

### *Differences in the Effects of Hierarchies Inside and Outside the ESN*

In a first step, we aimed to investigate if the effects of hierarchies on communication and collaboration inside the ESN are the same as outside the ESN. These effects are recognizable in with whom (resp. hierarchical level) persons communicate and collaborate. Therefore, for each year and each hierarchical level, respectively, we calculated the distribution of communication partners as well as collaboration partners among the different hierarchical levels. For doing so, for each hierarchical level we calculated the share of communication and collaboration partners among the hierarchical levels. Here, for instance, in the ESN in 2014 30% of the communication partners of a person on level 3 were persons on level 3, while 45% of the communication partner were on level 4, 7% on level 6 and so on. This was done for communication and collaboration inside and outside the ESN for each year respectively. Then, we applied a chi-squared test for homogeneity (Pearson 1900) to compare the respective distributions inside and outside the ESN. A chi-squared test for homogeneity can be applied to categorical data in order to determine whether frequency counts (here: communication partners among the hierarchical levels) are distributed identically across different populations (here: inside and outside the ESN) (cf. e.g., Greenwood and Nikulin 1996).

Table 4 shows the results of the chi-squared test for each hierarchical level. For level 6 for instance, we observe a test value of 53.76 for communication in 2013. For this test value, we have to reject the hypothesis that for this year and hierarchical level, communication partners inside and outside the ESN share the same

distribution (for  $\alpha=0.01$ ). Thus, we found evidence that for level 6 and 2013 the effects of hierarchies on communication inside and outside the ESN differ significantly.

The results (cf. Table 4) further indicate that this holds true not only for level 6 and communication in 2013 but also for all other hierarchical levels and communication in both years (except for level 4 in 2014). In addition, similar results can be observed for collaboration in the years 2013 and 2014. Hence, we found evidence that the effects of formal hierarchies inside and outside the ESN do not only differ with respect to communication but also with respect to collaboration.

Overall, the results show that a person's behaviour inside the ESN significantly differs from his or her behaviour outside the ESN with respect to whom the person communicates and with whom the person collaborates. This means that inside the ESN persons interact with persons from other hierarchical levels than they do outside the ESN.

<b>Table 4. Results of the Chi-squared Test for Homogeneity (including Level of Significance <math>\alpha</math>)</b>				
<b>Hierarchical level</b>	<b>Communication</b>		<b>Collaboration</b>	
	<b>2013</b>	<b>2014</b>	<b>2013</b>	<b>2014</b>
Level 6	53.76***	30.00***	66.97***	40.84***
Level 5	11.32*	18.75***	14.72**	10.74*
Level 4	15.81**	4.79	33.11***	30.72***
Level 3	64.67***	38.25***	83.82***	96.89***
Level 2	101.59***	56.36***	125.00***	100.00***
Level 1	16.74**	11.02*	100.00***	35.07***
*** $\alpha=0.01$ ** $\alpha=0.05$ * $\alpha=0.1$				

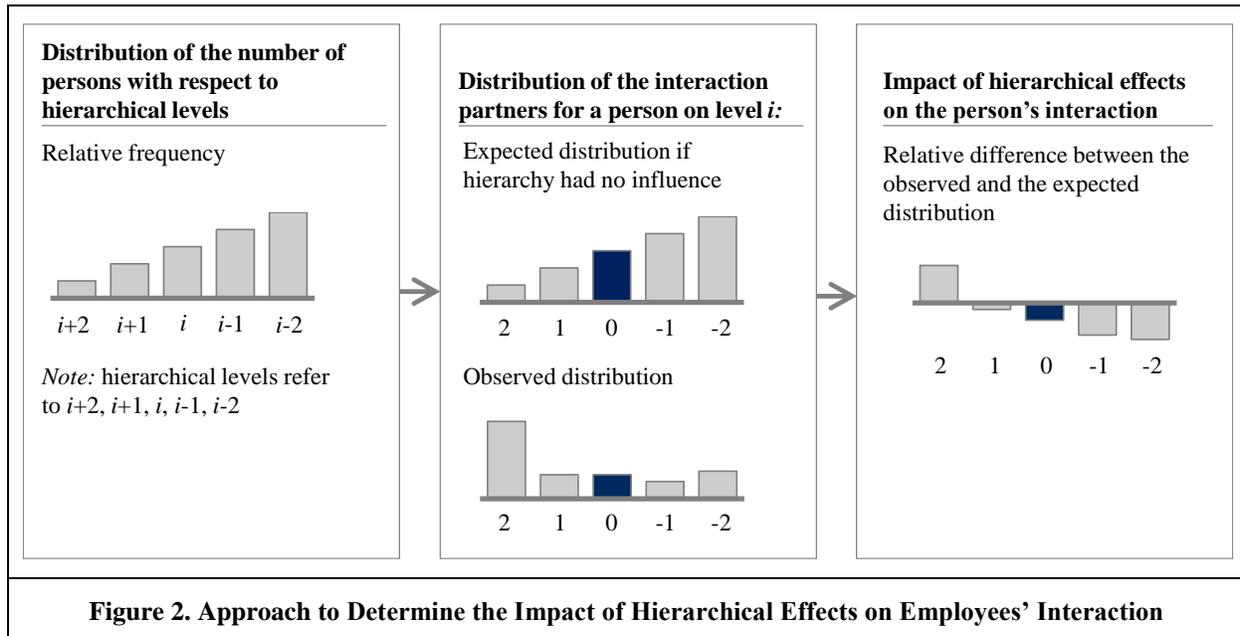
**Table 4. Results of the Chi-squared Test for Homogeneity (including Level of Significance  $\alpha$ )**

### ***Impact of Hierarchies on Employees' Interaction***

Further, we aim to analyse how the hierarchical effects influence communication and collaboration inside and outside the ESN. Since the number of persons in each hierarchical level varies greatly in size (cf. Table 2 and Table 3), a population bias (Howison et al. 2011) could skew the results. For instance, in the ESN in 2013 a person on level 4 may have 25 communication partners among his or her peers (i.e. on level 4) and two communication partners on level 7. Hence, based on mere absolute numbers one might argue that most interaction partners belong to the same hierarchical level while communication partners on level 7 are clearly underrepresented. However, as already noticed, the number of persons on each hierarchical level varies greatly in size: while in 2013 there are only seven Med-Net users on level 7, there are nearly a hundred times more users on level 4 (cf. Table 3). Hence, the absolute number of possible interaction partners on level 7 is much smaller than the absolute number of possible interaction partners on level 4. To allow comparisons regarding the extent of interaction in terms of the number of interaction partners on different hierarchical levels we have to consider both, the number of actually observed interaction partners and the number of possible interaction partners on the respective hierarchical level in Med-Net. This is because communication and collaboration may not only be subject to the influence of hierarchy, but also to the sheer number of persons on the respective hierarchical level.

If hierarchy had no influence on the interaction between persons, the number of a person's interaction partners on a certain hierarchical level would be proportional to the number of persons on the respective hierarchical level. If, for instance, the number of persons on level 1 is as four times as the number of persons on level 3, it would be expected that a person has four times more interaction partners among persons on level 1 than among persons on level 3. In the following, to account for this fact, we compare the observed distributions of communication partners and collaboration partners inside and outside the ESN to the

respective expected distributions if hierarchy had no influence. The underlying idea of using the expected distribution if hierarchy had no influence is illustrated in Figure 2.



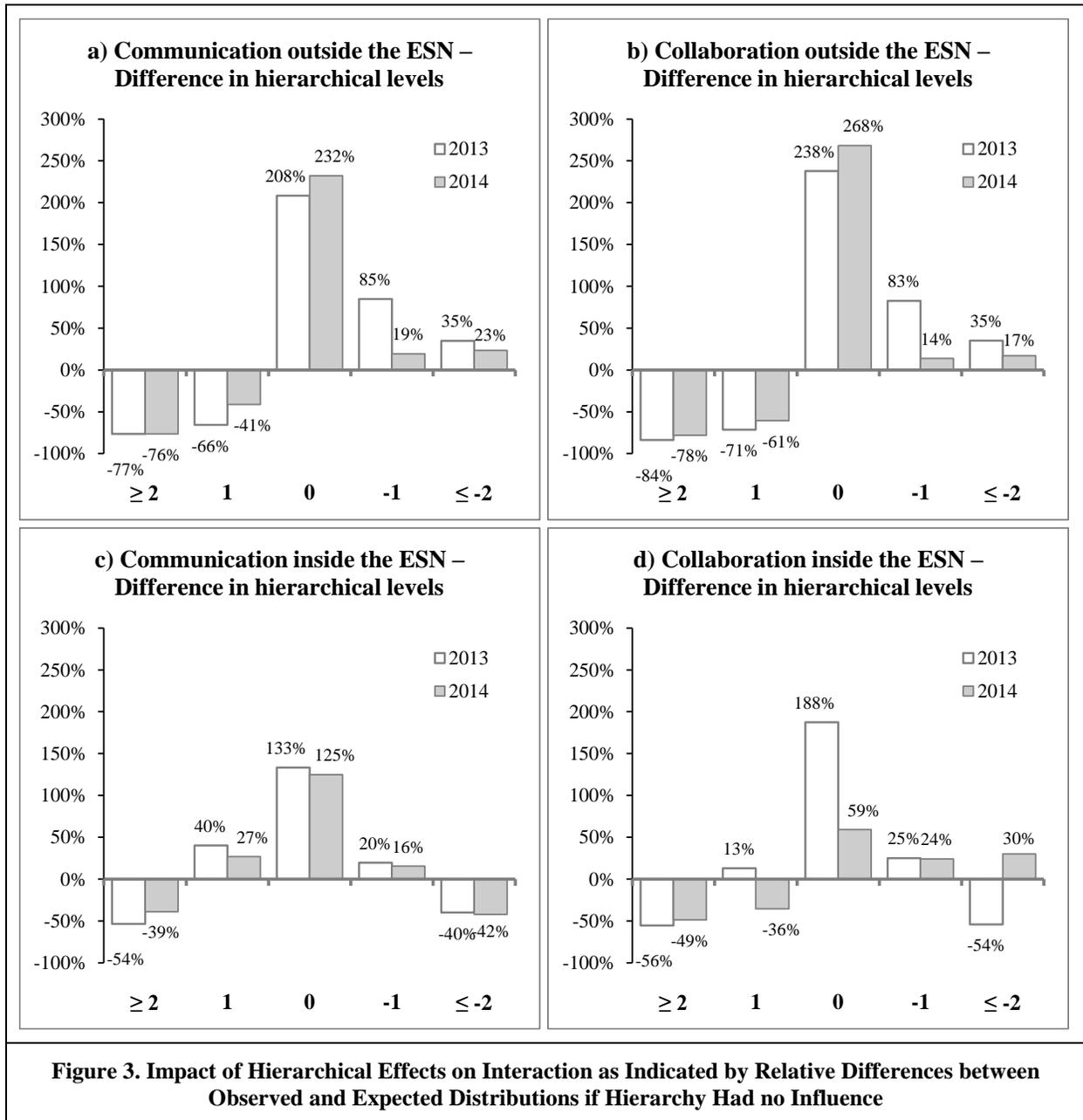
For reasons of simplicity, Figure 2 only comprises five hierarchical levels ( $i+2$ ,  $i+1$ ,  $i$ ,  $i-1$ , and  $i-2$ ), where  $i+2$  is the highest and  $i-2$  is the lowest level. The left-hand side of Figure 2 illustrates the distribution of the number of persons with respect to the hierarchical levels. This distribution is used to represent the expected distribution if hierarchy had no influence on a person's interaction (i.e. communication or collaboration) partners depending on the hierarchical levels, respectively the differences in hierarchical levels. Positive differences in hierarchical levels refer to interaction with persons on higher levels, while negative differences indicate interaction with persons on lower hierarchical levels. Regarding the example in Figure 2, for a person on level  $i$  the difference is 2 for interaction with persons on level  $i+2$  and  $-2$  for interaction with persons on level  $i-2$ . Due to the smallest number of persons on level  $i+2$  and the highest number of persons on level  $i-2$ , a person on level  $i$  is expected to have the smallest number of interactions with persons who are two levels higher and the highest number of interactions with persons who are two levels lower. The actually observed distribution of interaction partners may differ from this expected distribution (cf. centre of in Figure 2).

In the following, to determine the impact of hierarchical effects on employees' interaction, we calculate the relative differences between the values of the actually observed distribution and the respective values of the expected distribution if hierarchy had no influence (cf. right-hand side of Figure 2). In Figure 2, this results in a positive relative difference for a difference in hierarchical levels of 2 while the other relative differences are negative. Indeed, the relative frequencies of interaction partners on all other hierarchical levels ( $i+1$ ,  $i$ ,  $i-1$ , and  $i-2$ ) are lower than expected if hierarchy had no influence.

Based on these theoretical considerations, for each person we calculated the relative differences between the values of the actually observed distributions of the interaction partners and the respective values of the expected distributions of the interaction partners if hierarchy had no influence for each hierarchical level. For reasons of comprehensibility, we decided to aggregate the data for all users. We are aware that not all hierarchical levels have the same number of higher and lower levels. For instance, level 6 has just one higher level (i.e. level 7) but level 4 has three higher and three lower levels. Thus, we considered the respective numbers of hierarchical levels that can theoretically be bridged as well as the share of persons on the respective hierarchical levels as weights in our analysis.

Figure 3 shows the aggregated results depending on the respective differences in hierarchical levels. Thereby, as introduced above, positive differences in hierarchical levels represent interaction with persons

on higher hierarchical levels and vice versa. Moreover, for reasons of clarity and comprehensibility all communication and collaboration that bridges at least two hierarchical levels was aggregated.



The upper part of Figure 3 refers to communication (cf. diagram a)) and collaboration (cf. diagram b)) outside the ESN. Here, for instance, the relative frequencies of communication partners on the same hierarchical level (i.e., difference in hierarchical levels of 0) are 208% (for 2013) respectively 232% (for 2014) higher than it would be expected if hierarchy had no influence. In contrast, the relative frequencies of communication partners on the next higher level are 66% (for 2013) respectively 41% (for 2014) lower than expected. According to our results, hierarchy seems to have a strong influence on communication outside the ESN. Indeed, it is particularly remarkable that persons primarily tend to communicate with their peers resulting in strongly over proportional numbers of communication partners on the same level (for communication the observed distributions significantly (for  $\alpha=0.01$ ) differ from the expected distributions if hierarchy had no influence). Further, it becomes evident that there is much less communication with

persons on higher hierarchical levels. This also holds for collaboration outside the ESN. While people tend to collaborate with their peers and subordinates, less collaboration than expected is observed with superiors. Here, the distributions differ significantly (for  $\alpha=0.01$ ) too.

The lower part of Figure 3 refers to communication (cf. diagram c)) and collaboration (cf. diagram d)) in the ESN. The results reveal that in the ESN persons also primarily communicate with their peers: we found that the observed distributions for communication significantly (for  $\alpha=0.01$ ) differ from the expected ones if hierarchy had no influence. Moreover, the more hierarchical levels communication has to bridge, the less persons actually communicate with each other (cf. decreasing relative differences). For collaboration in the ESN, we observed a strong hierarchical influence for 2013 (observed distribution significantly (for  $\alpha=0.01$ ) differs from the expected one). However, collaboration behaviour within the ESN obviously changed in 2014. Indeed, for this year the results indicate a reduced impact of hierarchical effects and the observed distribution does not significantly (for  $\alpha=0.01$ ) differ from the expected one if hierarchy had no influence.

Summing up, we found that hierarchy significantly influences communication and collaboration inside and outside the ESN. Persons primarily tend to interact with their peers and barely bridge multiple hierarchical levels. However, the effects of hierarchies inside and outside the ESN differ to some extent. Within the ESN the hierarchical effects seem not as strong as outside the ESN. While outside the ESN communication and collaboration with superiors seems to be heavily limited, interaction inside the ESN seems to be more open. Here, persons communicate and collaborate more with superiors than outside the ESN. In contrast, inside the ESN persons tend to interact less with their subordinates. Thus, in the ESN interaction seems not to be limited by a clear line of control and command while outside the ESN a top-down line can be observed. Finally, while hierarchical effects outside the ESN seem to barely change over time, comparing interaction inside the ESN for the years 2013 and 2014, we observe a decrease of hierarchical effects on collaboration. Hence, it may be argued that over time ESN can contribute to reducing hierarchical effects in an organization and can lead to flatter hierarchies.

## Discussion

We aimed to investigate the effects of formal hierarchies on employees' interaction (i.e., communication and collaboration) inside and outside ESN.

Interaction outside ESN comprises all kinds of professional interaction that is done personally or via the use of traditional media such as telephone or email between two or more persons. This allows us to draw conclusions about the effect of ESN compared to other media. The findings contribute to theory and practice in different ways. Overall, our results provide insights into how people behave regarding their communication and collaboration partners inside and outside ESN with respect to the influence of formal organizational hierarchy. The hierarchical effects can be recognized by the amount of interaction between the different hierarchical levels – i.e., how much interaction with respect to communication and collaboration takes part between a person and other persons on the same level (peers), on higher levels (superiors), or on lower levels (subordinates).

### *Differences in the Effects of Hierarchies Inside and Outside the ESN*

First of all, our findings show that the hierarchical effects, i.e. a person's behaviour with respect to whom to interact, inside and outside the ESN, differ significantly (cf. Table 4). More precisely, the observed medical employees communicate and collaborate more with people from other hierarchical levels than they do outside the ESN. From a management perspective, this is of special interest for those responsible for introducing ESN. Other studies have shown that ESN can act as space for networking and crowdsourcing. They can be used for discussion, input generation, idea generation as well as informal talk beyond formal professional guidelines (Richter and Riemer 2013). This leads to better and faster decisions, increases the innovative capacity of a team and raises awareness for occurring problems and their solutions. For all this to happen it is important that the employees do not stick to themselves, but use the full potential of their colleagues that goes beyond their social capital (Faraj et al. 2011; Steinfield et al. 2009). In other words, communicating and collaborating across different hierarchical levels means using the full potential of the existing organisational knowledge. The Med-Net users seem to have recognized these benefits of the ESN and use the ESN beyond their interaction patterns regarding their tasks in their daily work. For instance, they use the ESN to extend their knowledge by collaborating with others from different hierarchical levels

in the knowledge base or actively communicating experiences and knowledge with other users apart their usual professional environment.

### ***Impact of Hierarchies on Employees' Interaction***

Second, our study sheds light into the impact of hierarchy on interaction, i.e. communication and collaboration. Although the effects of formal hierarchies inside and outside the ESN differ, we could observe that employees generally tend to communicate and collaborate more with their peers – i.e. colleagues on the same hierarchical level (cf. Figure 3). While communication and collaboration behaviour outside the ESN seems to be more controlled by a regime of administrative procedures and job roles defined by higher level superiors (Powell 1990; Putzke et al. 2010), also inside the ESN employees seem to bear in mind the hierarchal level of others for their interactions (also see Riemer and Richter 2010). The persistence of hierarchies not only outside but also inside the ESN might be explained with a number of reasons. One is that the employees have appropriated Med-Net in a way that reproduces their daily practices. People within the same hierarchical level are more likely to share similar interests as well as communication practices (West et al. 1999). Another reason is that people might try to minimize communication with higher levels beyond their daily work as they try for instance to avoid being perceived as a careerist or sycophant. Some might even expect professional disadvantages if superiors consider their behaviour in the ESN to be disrespectful or inappropriate. We do not have data to proof this hypothesis and would like to investigate this question in further studies.

### ***Reduced Impeding Effect of Hierarchy***

Third, nevertheless the most interesting result is that the impeding effect of not communicating due to hierarchy seems to be weaker inside the ESN than outside the ESN (cf. Figure 3). This impeding effect is clearly recognizable for interactions outside the ESN, i.e. employees tend to interact with their subordinates in preference and hesitate to interact with superiors. In contrast, inside the ESN these strict hierarchical structures seem to be erupted. Here, the differences between the observed distributions of communication and collaboration partners on the one hand, and the respective expected distributions if hierarchy had no influence on the other hand, are smaller than outside the ESN. Inside the ESN employees do communicate less with their subordinates and more with superiors than outside the ESN. A reason for the shift from communication with subordinates to superiors can be that employees are less hesitant to interact with superiors than they would be outside the ESN as they use the ESN, for instance, for seeking advice and additional knowledge. From a managerial perspective, this is of interest for organizations to foster interaction across hierarchies. For instance, ESN can facilitate the participation from all hierarchical levels during the creation of new innovations, can help to create a more open firm culture where also subordinates interact with higher level superiors beyond their formal organization, and can support business transformations (e.g., as a vehicle in digital transformations) by enabling a more networked communication and collaboration. This enables for instance senior managers to be close to actual business, worries, and needs of their staff, and to experience the progress of their transformation. This is in line with other studies that showed how senior managers successfully used ESN to be able to respond to the needs of their employees (Riemer et al. 2011).

### ***Effects over Time***

Further, we showed that initially the impact of formal hierarchies was higher for collaboration than for communication but changed over time. In 2014, the formerly high impact of hierarchy on collaboration nearly vanished. In line with what was stated earlier, users need time to get used to this new form of open communication and collaboration and to appropriate the ESN into their work practices (Richter and Riemer 2013). Nevertheless, our results show that the strong and persisting impact of hierarchy on communication and collaboration can slightly decrease over time. Or in other words: it may be argued that over time ESN contribute to reducing hierarchical effects and may lead to flatter hierarchies. To the best of our knowledge our study is the first to show based on large datasets that the impact of hierarchy on communication and collaboration can slightly decrease over time and we hope that there will be other studies to further study this effect.

## ***Methodological considerations***

Finally, triangulating data from two sources (i.e. data on interaction inside the ESN from a log file and data on interaction outside the ESN via an online survey) as research method allowed us not only to investigate the hierarchical effects inside and outside the ESN, but also to investigate how both differ. Whereas other authors (e.g., Behrendt et al. 2015; Riemer et al. 2015) have only considered data from inside the ESN, our method allows a more in-depth investigation of the interplay of ESN and formal hierarchy. Indeed, we are able to draw conclusions on how the people's behaviour inside differs from their behaviour outside the ESN and how this is affected by hierarchies. Hence, our paper allows a much more comprehensive view on how formal hierarchies effect interactions in ESN in relation to other communication than prior research (e.g., Behrendt et al. 2015; Riemer et al. 2015).

## ***Limitations and Further Research***

Although our findings provide first and interesting insights into the differences of hierarchical effects inside and outside ESN, they have to be seen in the light of several limitations. First, we only studied one single institution. Nevertheless, the case of Med-Net was selected for its high transparency of the hierarchical structures which allows us to clearly differentiate between hierarchical levels and to thoroughly analyse the hierarchical effects. Whereas military organizations might differ from business organizations in some points, comparable hierarchical structures (i.e. bureaucratic/orthodox organizations), where all positions are placed along official lines of top-down command and control, can also be found in other organizational contexts outside the military domain (Corominas-Murtra et al. 2013), for example in large organizations or in the consulting business (Stieglitz et al. 2014). Further studies can support to confirm the findings of this study.

Second, we only analysed two types of interaction. Obviously, communication and collaboration cannot completely reflect users' behaviour in ESN, which also takes part in the creation of social relationships. However, it might be assumed that the selected kinds of interactions are important and well-used functionalities of ESN. While in a first step it seemed appropriate to use communication and collaboration as examples for users' behaviour inside ESN, further studies are needed to analyse other types of relations such as social relationships.

Third, we did not consider individual attributes like age, gender, and experience (e.g., years of service) explicitly. While, the hierarchical levels may already partly reflect age and experience, this leaves room for further studies. Finally, although we considered different time frames, the network dynamics were not the focus of this study. This leaves room for future research considering the investigated effects over longer periods of time in more detail.

## **Conclusion**

Ever more organizations have been adopting ESN to foster collaboration, communication, and knowledge sharing among employees (Aral et al. 2013; von Krogh 2012). While there is a growing body of literature in the emerging field of ESN, we observe a lack of research focusing on the interplay of formal organizational hierarchies and users' behaviour in ESN. In order to use the full potential of the organisation's knowledge it is important that the employees do not stick to the same hierarchical level, but use the full potential of their colleagues that goes beyond their own social capital (Faraj et al. 2011; Steinfield et al. 2009). In other words, companies have an interest for organizations that use ESN to foster collaboration across hierarchies.

In this context, the aim of this paper was to investigate how formal organizational hierarchy affects employees' interaction inside and outside ESN and how these effects differ. Our research is spurred by a plethora of data generated in ESN when users connect and communicate with one another (Giles 2012) as well as data from an online survey. This data wealth allows for great opportunities to investigate and understand the interplay of formal organizational hierarchies and employees' behaviour.

We could show that formal organizational hierarchies significantly affect the way employees interact with each other inside and outside the ESN. Thereby, employees generally tend to communicate and collaborate with persons on the same hierarchical level but barely bridge different hierarchical levels. However, it has to be noted that hierarchical effects on employees' interaction inside and outside ESN differ to certain extent. While people tend to interact along a top-down line of command outside the ESN, interaction inside

the ESN seems to be more open and not as limited. Moreover, we observed first indications that hierarchical effects on collaboration in the ESN tend to decrease over time. Thus, it might be assumed that ESN can contribute to reducing hierarchical effects in organizations and can lead to flatter hierarchies.

With our paper, we hope to contribute to a better understanding of the emerging phenomenon of ESN. Summing up, we believe that our work is an important step towards better understanding the interplay of formal organizational hierarchies and users' behaviour in ESN. We hope that our paper will stimulate further research on this fascinating topic and will serve as a proper starting point for future work.

## Appendix: Questionnaire to Survey Interaction outside the ESN

In the following, please find an excerpt of the questionnaire used to survey employees' interaction (i.e., communication and collaboration) in their daily work outside the ESN. As the questions for the two years surveyed (i.e., 2013 and 2014) are analogous, we focus on the general schema of the respective questions.

### ***Intro: Interaction in your daily work at the German Armed Forces***

The following questions refer to your interactions within your daily work at the medical service unit of the German Armed Forces. For our research, it is important to find out, with whom you actively communicate and collaborate. Thereby, we are explicitly not interested in the names of concrete persons and colleagues but rather in their hierarchical levels.

Please note: The following questions do explicitly NOT refer to the ESN Med-Net! Rather, we are interested in learning more about your interactions in your daily work outside Med-Net.

### ***Communication***

In the following, we would like to ask you about persons in the medical service unit of the German Armed Forces, with whom you actively communicated in your daily work. Please think of all persons, who you contacted for example by e-mail, phone, mail, or personally (also answers to previous communication).

1. On average, with how many different persons in the medical service unit of the German Armed Forces did you communicate in an exemplary workweek in 2013 [resp. 2014]?
2. How are these communication partners distributed among the different hierarchical levels? Please keep in mind that the sum of your statements must amount to 100%!

General	[Pick List: 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%]
Staff officer	[Pick List: 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%]
Captain	[Pick List: 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%]
Lieutenant	[Pick List: 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%]
NCO	[Pick List: 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%]
Enlisted soldier	[Pick List: 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%]
Civilian	[Pick List: 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%]

### ***Collaboration***

In the following, we would like to ask you about persons in the medical service unit of the German Armed Forces, with whom you actively and directly collaborated in your daily work. Please think of all persons, with whom you collaborated, for example on the same tasks or projects.

1. On average, with how many different persons in the medical service unit of the German Armed Forces did you collaborate in an exemplary workweek in 2013 [resp. 2014]?

2. How are these collaboration partners distributed among the different hierarchical levels? Please keep in mind that the sum of your statements must amount to 100%!

General	[Pick List: 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%]
Staff officer	[Pick List: 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%]
Captain	[Pick List: 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%]
Lieutenant	[Pick List: 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%]
NCO	[Pick List: 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%]
Enlisted soldier	[Pick List: 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%]
Civilian	[Pick List: 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%]

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