THE WAYS COMMUNICATION EASE KNOWLEDGE SHARING:

AN EXAMINATION OF THREE ORGANIZATIONS WITH KNOWLEDGE-

INTENSIVE SERVICES

by

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ABSTRACT OF THE DISSERTATION

The ways communication ease knowledge sharing:

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Over the decades, practitioners and researchers alike have increasingly focused on how organization members can effectively share knowledge in an effort to create and maintain knowledge-intensive services. The growing interest in knowledge sharing is due in part to the increased digitalization and specialization of work practices. For example, the advance of computer-aided design, 3D printing, programming languages, financial regulation, and algorithmic stock trading places an increasing requirement on organization members to keep up with changes in their environment. Rapid technological and regulatory changes drastically impact and change how knowledge-intensive services must be approached. Organization members are unable to independently develop the expertise needed to create, maintain, and deliver complex services on their own. Knowledge sharing allows organization members to rely on others to provide services.

Effective knowledge sharing increases organizational member's performance, and in turn benefits organizations. However, organization members are faced with challenges that hinder knowledge sharing. Organization members become experts by repeatedly engaging in their area of expertise. Repeated engagement in an area limits the ability to

generate expertise in other areas. The way organization members approach problems, the solutions they see, and the way they communicate is impacted and grounded by their repeated engagement. Organization members with different expertise have unique vocabulary, interpretations, and work practices.

This dissertation examines how awareness of differences and the development of common ground between organization members can ease knowledge sharing. In doing so it is tested whether awareness of difference is sufficient for knowledge sharing compared to the existence of common ground between organization members. A mixed methods approach, blending social network analysis with observations and interviews, is used to answer the primary research question and hypotheses. Observations, interviews, and social network data is used to map the communicative relationships between organization members and identify the statistical likelihood of their co-occurrence in three organizations. The observations and interviews are analyzed using a grounded theory approach and content analysis, while the social network survey data is analyzed using descriptive statistics, quadratic assignment procedures, and exponential random graph modeling. In aggregate, this dissertation examines the type of communication and relational mechanisms that ease knowledge sharing between organization members.

Acknowledgements

Throughout my life I have had a fascination with how people come together – at family gatherings, in friendship circles, sports clubs, political rallies, workgroups, research disciplines, military units, and organizations. My curiosity for how people come together, to have fun or reach important goals, has driven my exploration and fascination of the world. As a child I was brought to political rallies with my parents, during military service I experienced esprit de corps, and at university I explored how students work together. Common in all my experiences is an observation of how social relationships are essential in people's lives and the way they organize. This dissertation is a culmination of that curiosity, experience, and research.

I would not be where I was today without the help of my adviser, who guided me through all stages of my PhD by balancing between intellectual direction and giving me the freedom to explore my own avenues. Matt has been a mentor and great advocate. Without his continuous support, my intellectual journey would not have been possible.

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Chapter 1: Introduction

"If the strategically most important resource of the firm is knowledge, and if knowledge resides in specialized form among individual organization members, then the essence of organizational capability is the integration of individuals' specialized knowledge." – Grant (1996, p. 375)

Knowledge is important to understand because we are experiencing the bloom of an information society (Nonaka, 1994). Bell's post-industrial society has become a reality with the solidification of information-led and service-orientated economies in countries around the world. In the post-industrial society, communication and information are the source and outcome of knowledge production (Castells, 2000). Central to this argument is the role of knowledge as a means for organizations to achieve competitive advantage (Kuhn & Jackson, 2008). Scholars such as Grant (1996) and Nonaka (1994; Nonaka & Takeuchi, 1995) have laid the foundation for research taking a knowledge-based view of organizations and the practical insights informing organizations on how to strategically utilize knowledge. Understanding organizations as knowledge-intensive emphasizes intangible assets, services, and human capital in addition to the traditional focus on financing, infrastructure, and raw materials (Starbuck, 1992). Research has focused on how objects are used as a basis for sharing knowledge (Kellogg, Orlikowski, & Yates, 2006), the way organization members develop mental maps of who to reach out to (Kotlarsky, van den Hooff, & Houtman, 2012), and the factors that impact effective knowledge sharing (Cummings & Kiesler, 2008). However, effective knowledge sharing has often been found difficult to implement in organizations, leading researchers to examine the benefits of diverse perspectives (Edmondson & Harvey, 2017) and the challenges facing organization members engaged in knowledge sharing (Barley, Treem, & Kuhn, 2017).

The ongoing exploration in the knowledge-based view of organizations has sparked two diverging perspectives on how knowledge functions and can be managed. One perspective focuses on the cognitive elements of knowledge - how knowledge is formed and transformed cognitively (Grant, 1996; Reagans & McEvily, 2003). The second perspective focuses on the communicative interactions between organization members and how dialog generate and validate knowledge (Nonaka & Takeuchi, 1995; Wenger, 2000). In this dissertation, knowledge is seen as cognitively stored and created but transformed and validated through organization members engagement with others. As such, the importance of organization members expertise is recognized while emphasizing the importance of bringing knowledge into play with others. Despite epistemological disagreements about how knowledge functions and how knowledge is enacted in organizations, scholars have converged on the fact that the management of knowledge is a central challenge and opportunity for organizations. Moreover, knowledge is a key driver of organizations' competitive advantage and their ability to grow and adapt in a constantly changing environment (Kogut & Zander, 1992).

A central tension within knowledge research is the tension between the specialization and integration of organization members' expertise. The importance of specialization became renown globally by Henry Ford's reorganization of labor that placed a focus on specialized tasks, solvable by individual organization members, as it highlighted the value of efficient distribution of organizational work (Rosen, 1983). The advantage of classic horizontal organizational structures is to enable specialized subunits and the efficient distribution of organizational tasks. However, not all tasks can be broken down into smaller subcomponents that can be delegated to subordinates or to other

managers. Specialization of tasks has clear limitations in an information society, as a myriad of factors and elements impact the services and products offered by organizations (Grant, 1996). Research have pointed out the importance of bringing together organization members to solve complex problems or generate new products (Holland, Gaston, & Gomes, 2000). Engagement between organization members help refine ideas and develop solutions to complex problems (Hargadon & Bechky, 2006) Uzzi, Mukherjee, Stringer, and Jones (2013) showed the importance of joining organization members with a variety of expertise to increase the number and application of patents. Integrating organization members' knowledge helps facilitate coordination, learning, and adaption (Nonaka, 1994; Nonaka & Takeuchi, 1995). Organizations engage in restructuring (Browning, Beyer, & Shetler, 1995), technological deployments (Yuan, Fulk, & Monge, 2007), and relational interventions (Santos, Goldman, & de Souza, 2015) in an effort to find the balance between specialization and integration of organization members' knowledge that brings the most value. Knowledge interventions are used to reach strategic goals of the organizations, such as the breakdown of knowledge silos, creation of innovation teams, and the redistributing of tasks across specialized positions.

Finding a balance between individual specialization and integration of organization members' knowledge has proven to one of the critical challenges for contemporary organizations (Barley et al., 2017; Edmondson & Harvey, 2017). Managing the balance between specialization and integration has become increasingly important for organizations as societies are moving deeper into information and service driven economies (Bell, 1974; Powell & Snellman, 2004). In this regard, Barley et al. (2017) found that nearly 85% of scholarly articles identified in an extensive literature

review emphasized the integration of knowledge over specialization; this suggests a clear trend in research since the work begun with Bell in 1974. The reason for a focus on integration is that it is a central mechanism for organizations to realize strategic goals. The integration of varied expertise and knowledge is central to the creation and maintenance of knowledge-intensive services. However, researchers often put the locus of research on either specialization or integration. This dissertation deliberately aims to explore the balance between specialization and integration of knowledge in an effort to provide a nuanced understanding of when specialization and integration is sufficient and necessary. The specialization and integration of knowledge is examined by looking at the degree to which common ground between organization members is required for integration and knowledge sharing to take place and the degree to which awareness of difference is sufficient for knowledge sharing. Common ground is the shared language use, interpretation, and work practice between organization members while awareness of difference is the conscious identification of different language use, interpretation, and work practices. Understanding the degree to which awareness of difference and common ground is needed for integration of knowledge is important in directing our theoretical understanding of knowledge and informs the type of interventions that can unlock organizations' strategic use of knowledge.

Knowledge and Knowing in the Context of Organizations

To understand the concept of knowledge a distinction is often made between data, information, and knowledge. Understanding the difference between the concepts are important as it specifies the phenomenon under study and allows for the comparison of results across studies (Chaffee, 1991). For example, the concepts of information and

knowledge has been used interchangeably with the distinction that knowledge is the
information stored in the mind of organization members (Alavi & Leidner, 2001). Other
scholars have argued that knowledge is justified true belief (Nonaka, 1994) or the ability
to act on information (Orlikowski, 2002). In this dissertation, and building upon prior
research, data are seen as unorganized objective facts, information is the contextualized
and categorized assembly of data, while knowledge is the evaluation of, and actions
based on, information that is made possible by the expertise and experience of an
organizational member (Davenport & Prusak, 2000). In order to understand what it
means to know something a pragmatic description is used to provide a distinction
between data, information, and knowledge.

In organizations data are often captured to better understand customers, including
data such as structured records of transactions. Data alone do not describe why customers
buy a product but can be contextualized and categorized into information that can help
organization members understand it. For example, by combining and analyzing
transaction data an organizational member identifies two types of customers: a group of
customers that buy in the beginning of each month and a group of customers that buy
sporadically throughout the month. Based on the collection and combination of data,
information is created. The information helps the organizational member understand the
purchasing habits of the customers but does not answer the question of why the pattern
exists. The information about the two groups of customers is circulated among
colleagues. A colleague suggests that the two groups of customers are the result of
differences in discretionary income. She argues that the customer group that buys at the
beginning of the month must save to afford the product, while the other group purchases

the product as needed. To test the assumption a survey is distributed among customers about their income, and the results confirm that the difference in purchasing behavior is the result of variations in discretionary income. How did the colleague know that the customers' behavior was due to difference in discretionary income? The colleague made an estimated guess about the potential causes for the customers' behavior based on past experiences.

The knowledge held by the colleague made it possible to make an estimated guess based on the provided information. Thus, the prior example illustrates how knowledge is fluid, intuitive, and at times defies logic. Nothing in the information directly indicated that discretionary income was a reason for the customers' purchasing behavior. The knowledge held by the colleague led to a correct, even if partial, explanation. Knowledge can be described as the mix of experience, values, contextual information, and expert insight of organization members that allows for the evaluation of, and actions based on, information (Davenport & Prusak, 2000). Such a view sees knowledge as held cognitively by organization members but shaped and developed through experiences and interactions with others (Nonaka, 1994).

The degree to which knowledge is inherently a cognitive process or formed through communication has sparked contention among scholars, as various scholars place different emphases on the primary factors that influence how knowledge is created and reshaped (Cook & Brown, 1999; Hollingshead & Brandon, 2003; Kuhn & Jackson, 2008; Nonaka & von Krogh, 2009; Orlikowski, 2002). Early studies used information and knowledge interchangeably and perceived knowledge as a static entity belonging to organization members (Kogut & Zander, 1992). The understanding of knowledge as a

static entity is referred to as the knowledge perspective (Kuhn, 2014). In the knowledge perspective, knowledge is seen as formed and reshaped cognitively by organization members (Ipe, 2003). Knowledge that cannot be encoded into messages is seen as non-transferrable and the key concern of the research is to understand how to effectively transfer knowledge held by organization members (Kogut & Zander, 1992; Nonaka & Takeuchi, 1995). As such, communication is strictly seen as a medium of transmission between organization members (Kuhn & Corman, 2003). Knowledge statically transfers from one organizational member to another (Kogut & Zander, 1992). Seeing knowledge as static and cognitive has led researchers to focus on the abilities and skills of organization members, at the expense of understanding how discussions and misunderstandings between organization members themselves can shape knowledge.

However, in the 1990s a turn in epistemological understanding of knowledge took place that placed emphasis on dynamic and interactional aspects of knowledge (Cook & Brown, 1999). The emergent view of knowledge is referred to as a knowing perspective (Kuhn, 2014). The epistemological turn critiques the classic knowledge perspective for seeing knowledge as a commodity that is assumed codifiable and transferable among organization members. This emergent view argues that knowledge is not a one-way transfer but rather knowledge is shared dynamically between organization members. The knowing perspective argues that knowledge is culturally situated and an ongoing social activity (Kuhn & Jackson, 2008; Orlikowski, 2002). The main difference between the two perspectives is the degree to which knowledge can be shared, where knowledge resides, and how knowledge is enacted. Taking a knowing perspective puts focus on how communication occurs between organization members. Knowledge is formed and

reshaped through interactions within a given environment. It is not possible for

organization members to share all their knowledge, as they lack the ability to articulate

the complexity and situational character of their knowledge. In doing so knowledge is

considered a social construct where organization members ultimately mediate what

counts as knowledge (Blackler, 1995).

This dissertation follows a knowing perspective but acknowledges the cognitive

elements of knowledge. As such, knowledge is seen as belonging to organization

members' cognition but created and reshaped through communicative interactions. By

placing focus on communicative interactions, the unit of analysis swings from the

organizational member, toward the organizational member's actions and interactions with

others. At the most fundamental level, knowledge can be said to be created by

organization members' engagement with their environment that provide experience and

insight (Cook & Brown, 1999; Kuhn & Jackson, 2008; Nonaka, 1994). Organizations

cannot create or hold knowledge absent of their members (Nonaka, 1994; Polanyi, 1966).

Organizational knowledge is the knowledge held by and shared between organization

members (Cook & Brown, 1999; Nonaka, 1994). This epistemological approach means

that this body of work treats knowledge as stored cognitively but formed and reshaped by

the dyadic engagement between organization members. As such, emphasis is placed on

the communicative interactions between organization members as they are considered the

locus of knowledge. Knowledge sharing, a dynamic two-way process between

organization members, is a core mechanism by which knowledge is formed, shared, and

reshaped (Østerlund & Carlile, 2005). Knowledge sharing is the integration of knowledge

between organization members. In doing so the relational aspect of knowing is examined

using a social network perspective as this type of approach places an emphasis on the type of communicative interactions that can ease knowledge sharing between organization members.

Tacit and Explicit Knowledge as a Continuum

Taking a knowing perspective that is inherently relational draws attention to how organization members share knowledge through communication and how differences in routines, norms, and practices influence knowledge sharing (Kuhn, 2014). A knowing perspective brings attention to the elements of knowing that are unarticulated and material. As such a distinction is often made between explicit and tacit knowledge based on three properties; ease of sharing, potential for aggregation, and method for acquisition (Lam, 2000).

First, the ease of sharing explicit and tacit knowledge is a central differentiator between the two concepts. Explicit knowledge is easily codified and communicatively shared between organizational member without extensive experience with the subject matter. Explicit knowledge is the evaluation of information that can be shared between organization members through interactions, messages, and documents. Tacit knowledge differs from explicit knowledge by being difficult to articulate. Polanyi (1966, p. 4) describes tacit knowledge as how "we can know more than we can tell" Tacit knowledge cannot be abstracted and transferred across time and space independently of organization members.

Second, explicit and tacit knowledge differ in their ability to be aggregated. Explicit knowledge can be stored and retrieved from documents or technological repositories without the need of the organizational member that generated the knowledge.

In doing so explicit knowledge is able to be aggregated, such as a training program that adds new subject areas. Tacit knowledge on the other hand is both contextual and personal to an extent that aggregation is made impossible (Brown & Duguid, 2001). The realization of tacit knowledge's full potential requires the involvement and cooperation between organizational member (Orlikowski, 2002). Tacit knowledge is tied to the organization members and the routines, norms, and, work practices they have developed. Tacit knowledge can therefore not be stored; rather, tacit knowledge is held by organization members.

Third, the methods by which organization members obtain explicit and tacit knowledge vary. Explicit knowledge can be gained through formal study and logical deduction (Lam, 2000). Organization members can attend training sessions or use online education programs to attain explicit knowledge. In contrast, tacit knowledge is acquired by learning-by-doing and through organization members joint engagement with a problem (Nonaka & von Krogh, 2009). Tacit knowledge is generated through the variety of experience and involvement with problems that organization members engage in (Nonaka, 1994).

Even though explicit and tacit knowledge can be conceptually distinguished, they are not separate and discrete in practice (Lam, 2000). Tacit and explicit knowledge must be seen as the same concept at each end of a continuum, as tacit knowledge is formed and reshaped into explicit knowledge, and vice versa, through engagement with problems and communication with others (Cook & Brown, 1999; Nonaka & von Krogh, 2009). New knowledge is generated through dynamic interaction and the play between explicit and tacit knowledge. Cook and Brown (1999) describe it as a generative dance between

knowledge and knowing. The concept of tacit and explicit knowledge highlights the challenges of sharing knowledge effectively between organization members. Even when sharing explicit knowledge complications arise between organization members, as they understand, describe, and approach problems differently (Bruns, 2013; Phelps, Heidl, & Wadhwa, 2012). The concepts of explicit and tacit knowledge hint at the communicative and relational aspects of knowledge by highlighting that not all knowledge is codifiable and thus needs to be gleaned or experienced through practice. In doing so this dissertation sees knowledge and knowing as belonging on a continuum where physical and material locations of organization members are important factors to understanding how knowledge is shared.

Seeing knowledge and knowing as belonging on a continuum also highlights the tension between the specialization and integration of knowledge. Polanyi (1966) coined the term tacit knowledge in an effort to highlight that not all knowledge is transferable. Some forms of knowledge can be easily codified and transferred between organizational while others require an understanding of the context and experience of the organizational member providing the knowledge. Utilizing knowledge that is tacit in nature is hard to put into play within organizations. Tacit forms of knowledge are often referred to as 'sticky' because the knowledge is hard to move or extract from organization members (Brown & Duguid, 2001; Dougherty, 1992). Studies have shown that sharing tacit forms of knowledge requires active engagement, time, and dialogue between organization members (Carlile, 2004; Levina & Vaast, 2005). The key problem for organizations is therefore not the creation of new knowledge or access to varied types of expertise. The specialization of knowledge is characteristic of the information-led and service-oriented

economies but leads to challenges when sharing knowledge with others (Grant, 1996). As such, this dissertation focuses on the ways in which communication facilitate knowledge sharing between organization members by examining the degree to which awareness of differences and the development of common ground can help the integration and sharing of knowledge between organization members. By grounding this research in the tension between specialization and integration an emphasis is placed on the challenges associated with sharing knowledge by homing in on the communicative conditions that are sufficient and necessary for effective knowledge sharing.

Organization of the Dissertation

The structure of this dissertation is as follows. Chapter 1 provided an overview of the key concepts and the core questions driving this work. The main question sought answered is; what type of communicative relationships facilitate and co-occur with knowledge sharing. Chapter 2 provides an overview of the knowledge literature related to the knowledge sharing mechanism in organizations, the type of communicative relationships that facilitate knowledge sharing, and the challenges associated with knowledge sharing. Building upon prior work a distinction is made between organization members' awareness of others' difference and the development of common ground. The distinct of awareness of difference and the development of common ground lay the foundation for the proposed research question and hypotheses. Chapter 3 details the data and methods deployed in this dissertation. The research procedures were deployed at a software development, medical device design, and financial service company. The collected data includes observations, interviews and a survey that was used to collect social network data. Content analysis was used to analyze the qualitative data, while the

quantitative data is analyzed using descriptive statistics, quadratic assignment procedures, and exponential random graph modeling. Chapter 4 provides the results of the content and social network analyses by providing descriptive and statistical findings. Next, chapter 5 builds upon results by integrating the qualitative and quantitative findings to understand the degree to which awareness and common ground facilitate knowledge sharing. Lastly, chapter 6 provides a discussion of the theoretical and practical implications of the findings while providing future directions for the research.

Chapter 2: Literature Review

"Work practice is generally viewed as conservative and resistant to change; learning is generally viewed as distinct from working and problematic in the face of change; and innovation is generally viewed as the disruptive but necessary imposition of change on the other two. To see that working, learning, and innovating are interrelated and compatible and thus potentially complementary, not conflicting forces, requires a distinct conceptual shift." – Brown and Duguid (1991, p. 40)

To understand the type of communication between organization members that can ease knowledge sharing, the following chapter examines how knowledge unfolds in organizations, emerging between organization members, being facilitated by relationships, and the challenges associated with sharing knowledge with others. Research surrounding knowledge processes have a distinct focus on how contexts, technology, practices, and connections influence how organization members' knowledge come into play in organizations (see Barley et al., 2017; Canary & McPhee, 2011; Kuhn, 2014). The following section highlights the major areas of research surrounding knowledge and provides the background for a theoretical understanding of the mechanisms that drive knowledge sharing in organizations.

At the macro level, knowledge researchers have mapped the factors that result in successful consortia, alliances, and joint ventures between organizations (Sampson, 2007). Joint ventures are seen as important because they provide an avenue for knowledge sharing across companies, such as the SEMATECH consortia that lead to the international dominance of the US semiconductor industry in the face of increasing competition (Browning et al., 1995). Central to the research is the assumption that integration of knowledge provides a competitive advantage against outsiders. The underlying assumption is that increased knowledge sharing between members of different organizations increase performance and innovation (Argote, Beckman, & Epple, 1990;

Hansen, 2002). The focus of the research is on understanding the context between organizations that foster individual members knowledge sharing. For example, Argote, McEvily, and Reagans (2003) argued that organizations' properties, relationships with other organizations, and the characteristics of knowledge are central elements in understanding how knowledge is shared. The ability of members from different organizations to engage in knowledge sharing is dependent upon the knowledge's degree of complexity, ambiguity, and tacitness (Simonin, 2004). As such, the research has shown the ability of interorganizational cooperation to provide competitive advantages but also points out that effective knowledge sharing between organization members as the foundation for successful cooperation.

Another central area of interest within the knowledge literature is information technologies. Scholars recognize that information technology, like Yammer, Teams, and Slack, as holding the potential to store codified knowledge centrally while connecting organization members with experts that hold relevant tacit knowledge (Child & Shumate, 2007; Yuan et al., 2007). Technology can facilitate knowledge sharing by providing broad access to explicit knowledge, while also easing the development of relationships with experts that hold tacit forms of knowledge. However, organizations run the risk of technological knowledge repositories becoming abandoned as few organization members contribute to, or consume, the centrally stored knowledge (McDermott, 1999). The creation of effective incentive structures for contribution to knowledge repositories have been found hard to balance. Organization members often see knowledge technologies as wasteful and counterproductive, and thus lack motivation to engage with them (Vaast & Walsham, 2005; Wasko & Faraj, 2005). However, recent studies have highlighted the

ability of social media platforms to uncover 'who knows what' and thus guiding organization members in who they can seek out for knowledge on specific topics (Paul M. Leonardi, 2014). Organization members thus rely on forming relationships with others in order to engage in effective knowledge sharing.

A way for organization members to directly ease knowledge sharing with others comes through objects. A vast area of research in the knowledge literature has focused on examining objects as facilitators of knowledge sharing. Objects, such as repositories, standardized forms, and charts, can be used to facilitate knowledge sharing. Organization members have been found to use objects to streamline differences in interpretation (Carlile, 2002; Star & Griesemer, 1989; Swan, Bresnen, Newell, & Robertson, 2007). Objects are used by organization members to develop shared interpretations. For example, Faraj and Xiao (2006) found that organization members used co-created documentation to ensure similarity in interpretation of information, while Orr (1996) showed how storytelling can be used to create a shared interpretation of work tasks. A general finding across the knowledge research focused on objects is that shared interpretation and development of common ground helps facilitate knowledge sharing (Barley, Leonardi, & Bailey, 2012). Organization members who have a common interpretation of information are said to have an easier time sharing knowledge with one another.

Following trends from object-focused studies, an expanding body of research has turned to the interactional, structural, and relational mechanisms that can help knowledge sharing between organization members. Studies have found that organization members in structural positions, that allows them to connect to a variety of experts, exhibit higher

ability to generate innovations (Burt, 2004; Fleming, Mingo, & Chen, 2007). In this regard, scholars have shown how formal interventions focused on the interactions between organization members can influence their ability to effectively share knowledge (Okhuysen & Eisenhardt, 2002). Levina and Vaast (2005) showed that benefitting from interactions with others required that organization members actively negotiate the relationship. This prior research hints at the need for understanding how knowledge can be shared and integrated by organization members via relational and structural interventions.

The research surrounding knowledge has excavated the contexts, technologies, practices, and relational factors that impact knowledge sharing and revealed how the mechanisms that ease knowledge sharing can be difficult to identify. However, a common theme across the areas of research is the focus on integration of knowledge and the fact that knowledge sharing is an inherently relational activity. The dyadic interactions between organization members are the fundamental level of which knowledge sharing exist (Kotlarsky et al., 2012). Organization members need to communicate, build relationships, and know what others know to establish effective knowledge sharing with others. This suggests that communication is the key mechanism by which organization members can share knowledge, especially if the knowledge is sticky and tacit. To better understand the role of communication in the facilitation of knowledge sharing, the following section examines three central theories of knowledge; the theory of organizational knowledge creation, transactive memory, and communities of practice.

Knowledge Sharing in Organizations

The theory of organizational knowledge creation (Cook & Brown, 1999; Nonaka, 1994; Nonaka & von Krogh, 2009) is a meta-theoretical framework that has guided knowledge research. Concepts of transactive memory and communities of practice complement the theory of organizational knowledge creation. These concepts complement the theory of organizational knowledge creation by emphasizing the relations and interactions organization members are embedded in. Transactive memory posits that communication between organization members uncovers who knows what by making visible what knowledge individuals learn, store, and retrieve (Hollingshead & Brandon, 2003; Wegner, 1987, 1995). Communities of practice frames the individual as part of a larger social context, which brings attention to how interactions with other organization members facilitate and shape knowledge development (Lave & Wenger, 1991; Wenger, 2000). Studies on transactive memory systems often center on explicit forms of knowledge, while tacit knowledge play a vital role in the practice and context focused streams of research (Canary & McPhee, 2011; Kuhn, 2014). The three frameworks were selected as the organizational knowledge creation theory provides a framework for how knowledge is enacted in organizations, with the communities of practices being a primary driver of qualitative insights, while transactive memory has spearheaded quantitative findings. Together these frameworks provide an epistemological understanding of knowledge and a basis for examining the quantitative and qualitative approaches used to examine knowledge sharing. These approaches highlight the need for being aware of others expertise and differences, as well as the need to develop common ground to effectively share knowledge.

Organizational Knowledge Creation Theory. The theory of organizational knowledge creation posits that the continuous interplay between tacit and explicit knowledge can be categorized into four types of interactions; socialization, combination, internalization, and externalization (Nonaka, 1994; Nonaka & von Krogh, 2009). Socialization is the observation and imitation of others by an individual. Combination is the reassembly of explicit knowledge into new constellations. Internalization is the process in which tacit knowledge is formed by engagement with practice and explicit knowledge, while externalization is the conversion of tacit knowledge into explicit knowledge through communication. Knowledge creation takes place as the four types of interaction continuously intersect and are inherent in actions such as coordination, experimentation, discussion, and learning by doing.

Central to the theory is the communication between organization members that are central to each process. As such, communication scholars have examined each process and the role communication plays. Studies on socialization and internalization processes have stemmed from research grounded in communities of practice theory. The focus has been on understanding the ways in which knowledge is emergent and shaped by communication (Cooren, 2004; Kuhn & Jackson, 2008; McPhee, Myers, & Trethewey, 2006). Similarly, the combination process has received attention as scholars have honed in on knowledge sharing and the challenges associated with crossing communities of practice (Barley, 2015; Carlile, 2004; Paul M Leonardi, 2011b). Another research stream examines the internalization and externalization processes. Transactive memory is central to this line of research and the assumption that certain communication patterns and divisions of knowledge is efficient for knowledge work (Child & Shumate,

2007; Palazzolo, 2005; Yuan, Fulk, Monge, & Contractor, 2010). Additionally, the use of technology as a means to share explicit knowledge or information about 'who knows what' has been the subject of investigation (Child & Shumate, 2007; Yuan et al., 2005; Yuan, Zhao, Liao, & Chi, 2013). Common for the research examining the processes outlined by the theory of organizational knowledge creation is the focus on the communicative aspect of knowledge. Especially, the communicative relationships between organization members that central for both explicit and tacit forms of knowledge to be shared. The theory of organizational knowledge creation provides the general types of mechanisms that facilitate knowledge sharing. In doing so, it is highlighted that being aware of others expertise and knowing what others know is the foundation for knowledge sharing. In the following section, transactive memory is described in depth and it is highlighted how awareness is central to knowledge sharing.

Transactive Memory. Transactive memory explains the ways in which organization members can rely on other's knowledge to accomplish a common goal (Wegner, 1987, 1995). Transactive memory refers to the combined knowledge held by the members of a team, community, or organization. Metamemory is the information about 'who knows what' that helps an individual determine whom to turn to for certain knowledge. The formation of a transactive memory system relies on three processes; encoding, storage, and retrieval. Encoding is a continuous process in which organization members, through interaction and practice, learns about who did what, who knows what, and who are good at doing what. Engagement in knowledge sharing and information seeking help organization members gage others' domains of expertise. The concept of storage refers to the building of a metamemory and the redirection of knowledge to

domain experts, while retrieval is the use of metamemory to reach out to domain experts. The concept of transactive memory systems has played a central role in the development of a communicative approach to knowledge. Communication scholars have verified the basic assumptions of the theory, explored the benefits of transactive memory systems, and examined how technologies can facilitate knowledge sharing (Child & Shumate, 2007; Garner, 2006; Hollingshead, 1998; Hollingshead & Brandon, 2003; Yuan, Rickard, Xia, & Scherer, 2010).

The research surrounding transactive memory suggests that organization members need to be aware of other's differences in expertise to be able to seek them out. The frequency of communication between organization members is central to the development of metamemory, as interaction with others provides indications of who knows what (Yuan, Fulk, et al., 2010). These studies indicate that a well-functioning transactive memory system may be beneficial for performance. Being aware of others expertise is a key factor in the establishment of knowledge sharing ties. Despite awareness of others' expertise being necessary, it might not be sufficient for effective knowledge. The concept of communities of practice suggests that organization members needs to also develop a common ground to fully take advantage of others expertise.

Communities of Practice. The concept of communities of practice expands on the assumption that knowledge creation is rooted in shared practice and situated learning (Lave & Wenger, 1991; Wenger, 2000). Lave and Wenger (1991) expands on the process of internalization (Nonaka, 1994) and hypothesize how tacit knowledge is generated (Wenger, 2000). Central to the concept is the idea that communities of practice are formed through repeated interactions between organization members. The interactions

between organization members facilitate knowledge sharing by providing mutual exposure, sharing and engagement (Lave & Wenger, 1991; Wenger, 2000). The communities create common ground between organization members. Combined these interactions are argued to help the formation of knowledge sharing ties (Wenger, 2000). In addition to engagement, a continuous alignment of what constitutes knowledge is created through the interactions between organization members. The emergent nature of knowledge creates challenges for knowledge sharing, as members in communities of practice develop their own explicit and tacit knowledge. The concept and subsequent findings have led communication scholars to challenge a static understanding of knowledge. Generally, the studies focusing on communities of practice have shown how communication play a central role in what counts as knowledge, how knowledge is generated, and how knowledge is shared across communities (Barley, 2015; Carlile, 2004; Kuhn & Jackson, 2008; Leonardi, 2011).

Based on the assertion that knowledge is formed and shaped by the social environment, communication scholars have examined the challenges that arise when organization members engage in knowledge sharing. The goal is to map the challenges that arise when organization members engage in knowledge sharing but it has not been tested the degree to which common ground facilitate knowledge sharing. For example, Leonardi (2011) found that engineers had developed unique communities of practice that let to different understandings of how knowledge should be shared. The study illustrates how communities of practice can create challenges for knowledge sharing. Knowledge sharing comes with issues such as the risk of misinterpretation and loss of comprehension. Studies examining how organization members overcome challenges

experiences have identified 'trading zones' as important to break down barriers (Kellogg et al., 2006). The research suggest that the development of common ground is essential for successful knowledge sharing. The concept suggests that organization members needs to be more than just aware of difference but also actively work to create common ground.

Together the theory of organizational knowledge creation, transactive memory, and communities of practice point out the communicative nature of knowledge sharing and the issue facing organization members when engaging others. Organization members need to know who knows what, building an awareness of difference, while also creating common ground through the development of communities of practice. The following section builds upon an understanding of knowledge sharing by examining the opportunities and challenges organization members face when developing an awareness of difference and common ground.

Emergence and Facilitation of Knowledge Sharing

The ability of organization members to successfully share their knowledge is necessary to reap the benefit of expertise in an organizational context. Research examining knowledge sharing have focused on the communication patterns between organization members and how those communication patterns impact outcomes. It is argued that knowledge emerges through communication, as it is through organization members continuous interaction and engagement with one another that knowledge sharing takes place (Kuhn & Jackson, 2008; Orlikowski, 2002). The concept of social networks is central to the literature of knowledge sharing (Barley & Weickum, 2017b; Borgatti & Foster, 2003; Contractor & Monge, 2002). A focus on knowledge from a social network perspective reveals how knowledge sharing between organization

members can enhance performance and increase success by placing an emphasis on communicative ties (see e.g., Burt, 2004; Cummings, 2004; Cummings & Cross, 2003). For example, Cummings (2004) found that organization members that frequently engaged in knowledge sharing external to their project teams were high performing. The result can be explained by the extent to which the organization members' networks consisted of non-redundant contacts to provide access to expertise. The degree to which organization members are part of non-overlapping social networks increases access to more varied expertise and knowledge (Burt, 2004). Having access to varied perspectives and resources leads to higher performance, as organization members are able to engage with others about the best solutions to complex problems (Cummings, 2004). As such, the social networks of organization members are central to the facilitation of knowledge sharing. The communicative ties between organization members provide the foundation for knowledge sharing to emerge. Researchers studying knowledge has, in the last two decades, increased the focus and emphasis on the challenges facing organization members sharing knowledge (Borgatti & Halgin, 2011; Contractor & Monge, 2002; Yuan, Fulk, et al., 2010). However, the type of communicative ties that overcome challenges to knowledge sharing between organization members have remained elusive.

Research has shown that high frequencies of communication between organization members are necessary for knowledge sharing to take place, as interaction with others provide indications of who knows what (Hollingshead & Brandon, 2003). Knowing who knows what guides organization members when reaching out to others. Perceptions of expertise are developed through communication and influences who an organizational member turns to for knowledge sharing (Palazzolo, 2005; Treem, 2012).

Organization members need to have an accurate understanding of who knows what, organization members must be aware of others' domain of knowledge, in order to share knowledge. In this regard, Liao, Jimmieson, O'Brien, and Restubog (2012) point out that the quality of communication plays an important role in who organization members engage with when sharing knowledge. A central way for organization members to engage in knowledge sharing is the development of awareness through repeated exposure to others. Some studies suggest that awareness of differences in expertise between organization members is sufficient for effective knowledge sharing (Cummings & Kiesler, 2005; Kotlarsky et al., 2012; Palazzolo, 2005; Treem & Leonardi, 2015; Yuan, Fulk, Monge, & Contractor, 2009) while others have suggested the development of a common ground is additionally necessary (Barley & Weickum, 2017a; Bechky, 2003; Paul M Leonardi, 2011a; Orlikowski, 2002). Studies indicate that common interpretations of events are not necessary for effective knowledge sharing if organization members are aware of the differences in interpretation (Faraj & Xiao, 2006; Kellogg et al., 2006; Schmickl & Kieser, 2008). The separation of organization members' functions and roles limit the need to establish common interpretations, as awareness of differences lets organization members compensate and adjust for issues that raise (Rico, Sánchez-Manzanares, Gil, & Gibson, 2008). Common for both bodies of literature is the idea that knowledge sharing requires awareness of differences between organization members to mitigate misunderstandings. However, the degree to which the development of common ground between organization members are necessary for knowledge sharing remains untested.

The divergence in the literature can partly be attributed to the fact that organization members often face issues with the accuracy in the awareness of others expertise and difficulty in understanding each other (Kotlarsky et al., 2012). Organization members with varied expertise often use different terms to describe the same concepts, or the same word to describe different concepts, as well as terminology that is unique to a certain area of expertise (Bechky, 2003). Due to the challenges for organization members to share knowledge, research diverge on the role that awareness of difference in expertise have on knowledge sharing. Some scholars have found that to effectively share knowledge organization members need more than awareness of differences in expertise. For example, Galison (1997) found that physicists relied on a 'trading zone' of common knowledge to facilitate the flow of knowledge with others. As such, the development of shared language and values can be seen as vital for knowledge sharing to maturate (Barley, 2015). This suggests that awareness of differences in knowledge between organization members is necessary but insufficient for the successful sharing of knowledge.

Studies have pointed out that the advantage of knowledge sharing manifests itself when organization members develop a common ground of understanding by using similar words, shared goals, and common work practices (Barley & Weickum, 2017a; Edmondson & Nembhard, 2009). However, the development of common ground may not be necessary for knowledge sharing to take place and thus take attention away from the factors that are more important for facilitating knowledge sharing. Similarly, the development of a common ground comes with opportunity costs. The development of common ground takes time away from experts to execute on tasks they are most efficient

in solving and further develop their knowledge domain (Gratton & Erickson, 2007). This dissertation tests the degree to which the development of common ground is necessary for knowledge sharing to emerge. The following section highlights the challenges faced by organization members when engaging in knowledge sharing and leads to the main research question sought answered.

Challenges of Knowledge Sharing

Organization members are faced with several challenges when engaging in knowledge sharing. Knowledge is formed and reshaped through organization members' past experiences and engagement with others, which creates differences in the way organization members understand, describe, and approach problems (Edmondson & Harvey, 2017; Nonaka, 1994). For example, an employee with a marketing background has been trained to home in on what is popular among consumers, while a software developer has the technical skills to build a product that meets the demands of consumers. As such, the challenges for knowledge sharing can be understood as communicative and occurring at the interpersonal level of interaction (Kotlarsky et al., 2012). When organization members share knowledge with people who have different terminology, experience, and work practices challenges arise that make communication difficult (Brown & Duguid, 2001). Bringing together organization members with different expertise provides a broader range of potential knowledge but the differences between organization members adds challenges that hinder knowledge sharing (Mitchell, Parker, & Giles, 2011).

Polanyi (1966) and Carlile (2002) provide categorizations that are useful in understanding the obstacles surrounding sharing knowledge and understanding the

impact of awareness of difference and common ground on knowledge sharing between organization members. The tacit and explicit knowledge division proposed by Polanyi (1966) highlight how knowledge sharing can be hindered. Central to the continuum from explicit to tacit knowledge is the degree to which organization members can articulate their knowledge. The continuum highlight how organization members can be unaware of the knowledge they hold and how that knowledge can be of value to others. The explicit and tacit categorization is useful in understanding the challenges that organization members face when trying to share knowledge but does not highlight the type of communicative challenges that are associated with knowledge sharing. Carlile (2004) builds upon the explicit and tacit continuum by pointing to difference in language, interests, and practice between organization members that complicate knowledge sharing. Even if organization members are able to articulate the knowledge that they hold, others may not be able to fully comprehend and appreciate the knowledge. As such, organization members are faced with challenges of communicating knowledge that rests on differences in language, interests, and work practices.

Carlile (2004) proposes organization members are facing three main types of challenges that must be taken into consideration: language, goals, and work practice challenges. Language challenges refer to the differences in words used by two organization members. For example, language differences may negatively influence the accuracy of communication. For knowledge to be shared, it is argued that a common lexicon must be developed. Secondly, goal challenges are based on differences in systems of interpretation that impede how organization members understand issues and solutions. Carlile and Eric (2003) argues that when organization members come together to solve

problems, interacting, and producing outcomes, the closer the system of interpretation aligns. Lastly, work practice challenges exist based on the different and potentially competing work habits between organization members. Work practice challenges are illustrated by differences in what organization members count as valuable and their way of approaching a problem.

The three aforementioned challenges have been found to create obstacles for communication and impede knowledge sharing between organization members (Carlile, 2004; Kotlarsky et al., 2012; Liao et al., 2012). For example, language challenges have been found to impede the accuracy of communication between group members and thus the ability to share knowledge (Kotlarsky et al., 2012). Similarly, work practice challenges arise when organization members with different approaches to work have to share knowledge. Organization members tend to see members from other organizations, departments, and groups as less trustworthy (Williams, 2001), which leads to less willingness to provide useful information (Andrews & Delahaye, 2000) and absorb knowledge (Mayer, Davis, & Schoorman, 1995). Kotlarsky et al. (2012) found that the three challenges to knowledge sharing can be understood as reinforcing and hierarchical. For example, work practice challenges lead to increases in language challenges, which also increases goal challenges. However, the statistical relationship between knowledge sharing and communicative interactions found to ease knowledge sharing has not yet been explored. Understanding the type of communication that ease knowledge sharing can help organization members become more productive and innovative (Burt, 2004; Cummings, 2004; Cummings & Cross, 2003). Researchers have explored the communicative challenges that arise when two organization members come together to

share knowledge (Barley, 2015; Jarvenpaa & Keating, 2011; Kotlarsky et al., 2012). Knowledge sharing requires that organization members engage with each other to understand common grounds and differences in language, interpretation, and work practices (Bechky, 2003; Kellogg et al., 2006). This dissertation tests to what degree common ground between organization members is necessary for knowledge sharing. This leads to the following research questions:

> **RQ:** To what degree is awareness of difference and the development of common ground formed around the knowledge sharing ties of organization members?

In the following section, the concept of awareness of difference and the development of common ground are built upon, the research supporting each notion is examined, and hypothesis are developed. The section examines the type of communication between organization members that can facilitate knowledge sharing in an effort to develop hypotheses. The hypotheses rest on the three identified types of challenges identified by Carlile (2004) but builds upon them by making a distinction between awareness of differences and common ground, as studies have found awareness of differences is sufficient for efficient knowledge sharing while other research suggest that the development of common understandings are necessary (see e.g. Faraj & Sproull, 2000; Kellogg, Orlikowski, & Yates, 2006; Kotlarsky et al., 2012).

Foundational Ties for Knowledge Sharing

Frequent communication between organization members provides a foundation for knowledge sharing (Yuan, Fulk, Monge, & Contractor, 2009), as frequent communication leads to increases in trust and familiarity between organization members (Granovetter, 1973; Krackhardt, Nohria, & Eccles, 2003). Research has found that trust

motivates organization members to share resources (Gulati, 1995; Zaheer, McEvily, & Perrone, 1998) and to increase the chance of accurate and in-depth knowledge sharing (Uzzi, 1997). Frequent communication has been found to ease the sharing of tacit knowledge that is difficult to articulate in a short and concise manner (Palazzolo, Serb, She, Su, & Contractor, 2006; Yuan et al., 2009). Similarly, Cummings and Kiesler (2008) found that familiarity between organization members can ease collaboration. Familiarity between two organization members reduces uncertainty about how the other behaves and the language they use (Hinds, Carley, Krackhardt, & Wholey, 2000). Breaking down language challenges to knowledge sharing requires that organization members engage in frequent communication; doing so helps organization members increase the trust they have in one another. Organization members that are trusting of one another are more likely to further build their relationship. Frequent communication helps organization members to share knowledge by establishing awareness of differences in, and the development of common, language use, interpretation, and work preferences. This leads to the following hypothesis:

H₁: A higher frequency of communication between two organization members is likely to increase the quality of their knowledge sharing.

Despite the potential benefits of frequent communication, effective knowledge sharing requires more than just increased communication between organization members (Liao et al., 2012). Rich and meaningful communication between organization members is required in order for effective knowledge sharing to take place (Kotlarsky et al., 2012; Orlikowski, 2002). Rich and meaningful communication goes beyond frequency of communication. Rather, rich and meaningful communication in an organization is best

defined as a dynamic two-way dialog where organization members are able to accurately articulate themselves without misunderstandings. Kuhn and Jackson (2008) point out that knowledge sharing is a dyadic and communicative activity between organization members. By testing the degree to which organization members' knowledge sharing is reciprocated, the assumption of knowledge as a two-way dynamic process is tested.. In doing so the emphasis is placed on the dyadic and communicative interactions between organization members. In essence, what is tested is the degree to which mutuality is a byproduct of the network creation. The following hypothesis is therefore proposed:

> **H2:** Organization members are more likely to engage in knowledge sharing with organization members who reciprocate in sharing knowledge than what would be expected by random chance.

Understanding the role of communication and reciprocated knowledge sharing lays a foundation for examining the challenges to knowledge sharing and the type of communicative ties that facilitate knowledge sharing. In the following section, hypotheses are developed for organization members' awareness of difference in expertise and how awareness of differences impact knowledge sharing.

Awareness of Difference and Knowledge Sharing

Being aware of other organization members' expertise is an important and necessary factor in order for knowledge sharing to take place (Liao et al., 2012). Research has shown that establishing metamemory is directly related with the increased knowledge sharing as organization members know who to turn to when being faced with a decision or problem (Kotlarsky et al., 2012). However, organization members need to be aware of more than the type of knowledge that others hold. Knowing who knows is

the foundation which allows organization members to reach out the right experts. To engage in effective knowledge sharing, organization members needs to be able to understand the unique language use of the expert, the way the expert think about a problems, and the way that others go about solving problems (Carlile, 2004; Jarvenpaa & Majchrzak, 2008). The following section examines how awareness of difference in language, interpretation, and work practices between organization members can benefit knowledge sharing.

Language challenges. As frequent communication is established between organization members, differences in vocabulary are exposed (Lave & Wenger, 1991). Differences in vocabulary can lead to conflict between organization members if not anticipated and understood (De Dreu & Weingart, 2003; Edmondson & Nembhard, 2009; Lovelace, Shapiro, & Weingart, 2001). To that end, research suggests that organization members must be aware of differences in terminology and syntax in order to benefit from others' knowledge (Hansen, 1999; Nonaka & Takeuchi, 1995). Okhuysen and Bechky (2009) point out that knowledge sharing requires organization members to anticipate others' communication and to adjust their own communication accordingly. Reagans, Argote, and Brooks (2005) similarly found awareness of other's preferences and communication eased collaboration. Anticipating differences in language use by other organization members and tailoring interactions to those differences can facilitate knowledge sharing (Okhuysen & Bechky, 2009). The following hypothesis is therefore proposed:

H3: A higher awareness of differences in language use between two organization members is likely to increase the quality of their knowledge sharing.

Goal challenges. A goal challenge emerges between two organization members when they attribute different meanings and interpretations to information (Carlile, 2004). The past experiences of organization members create distinct professional principles, views, and habits that are taken-for-granted (Edmondson & Nembhard, 2009). The differences in assumptions between organization members are often unconscious and may result in differences for how organization members interpret information (Dougherty, 1992). When organization members' interpretations of information diverge and remain unconscious, challenges arise for knowledge sharing (Kotlarsky et al., 2012). For example, organization members may disagree about how the feedback from a customer should be interpreted. As organization members come together to share knowledge, differences in meanings and interpretations are manifested and revealed, which can lead to misunderstandings and conflicts (Hargadon & Bechky, 2006; Kuhn & Jackson, 2008).

Being aware of differences in interpretation can benefit knowledge sharing and collaboration between organization members (Oborn & Dawson, 2010). Being aware of differences may ease knowledge sharing, as organization members then are able to proactively anticipate conflicting interpretations due to their awareness of the underlying differences (Faraj & Xiao, 2006; Kellogg et al., 2006; Schmickl & Kieser, 2008). For example, Barley (2015) found that organization members, in an effort to ease knowledge sharing, changed the output of their work based on how they perceived others would interpret the work. In this regard, studies have suggested that common interpretations of events are not necessary for effective knowledge sharing if organization members are aware of the differences in interpretation (Faraj & Xiao, 2006; Kellogg et al., 2006;

Schmickl & Kieser, 2008). The specific functions and roles of organization members limit the need to establish common interpretations, as organization members can compensate and adjust for differences in interpretation (Rico et al., 2008). Thus, organization members can benefit from diverse knowledge if they understand others' interpretations of information (Kellogg et al., 2006; Majchrzak, More, & Faraj, 2011). This leads to the following hypothesis

> **H4:** A higher awareness of differences in interpretation between two organization members is likely to increase the quality of their knowledge sharing.

Work practice challenges. Even when organization members are aware of differences in understanding and interpretations of information, challenges arise with regards to differences in interests and work practices (Carlile, 2004; Cook & Brown, 1999). For example, a software developer may focus on applying the newest technologies while a project manager is focused on using proven technologies to finish the development of a software feature on time. Organization members who come together face difficulties creating comparable workflows while aligning diverse interests and goals. Differences in practice and job functions leads to issues about organization members' professional identity, 'us versus them' attitudes, perceptions of prestige and status, and how work is evaluated (DiBenigno & Kellogg, 2014; Liao et al., 2012). The knowledge organization members have honed are at stake when engaging with others (Carlile, 2002). Similarly, differences between organization members decreases motivation to develop an understanding and alignment of interests (Barrett & Oborn, 2010; Jarvenpaa & Majchrzak, 2008).

Organization members need to identify and become aware of differences in the work practices of other organization members in order to fruitfully engage in knowledge sharing and to reap the benefits of others' expertise (Carlile, 2004). When organization members are aware of differences in work practices, knowledge sharing becomes easier, as organization members are able take into consideration the want and needs of others (Reagans et al., 2005). Being aware of differences in work practices also help structure how work is conducted, as workflows can be made to accommodate differences in deadlines and expected results (Bruns, 2013; Paolo, Ernesto De, Vincenza, Marcello, & Mario Pezzillo, 2017). Organization members adjusting and accommodating to differences in work practices help facilitate knowledge sharing (Barley, 2015; Bechky, 2003; Paolo et al., 2017). The following hypothesis is therefore proposed:

H₅: A higher awareness of differences in work practices between two organization members is likely to increase the quality of their knowledge sharing.

Development of Common Ground and Knowledge Sharing

Despite awareness of difference between organization members are important for knowledge sharing, research suggest that the development of common ground is necessary as well. Organization members do not only have to be aware of how experts use language, their interpretation, and approach to problems. Organization members need to co-create and develop shared language, interpretations and work practices to fully take advantage of others knowledge (Bechky, 2003). To take advantage of others expertise organization members needs to know who knows what, being aware of how they understand and approach problems difference, as well as develop common frame of references and work practices. However, developing common ground requires time,

motivation, and engagement (Carlile & Eric, 2003; Levina & Vaast, 2008). The following

section examines the benefits of common ground can ease knowledge sharing by

proposing hypotheses that test the degree to which common ground is necessary for

knowledge sharing.

Language challenges. Even though awareness of differences in syntax between

organization members is vital for knowledge sharing, research suggests that sharing

knowledge requires more than just awareness of differences. In this regard, Bechky

(2003) found that the development of a common lexicon helped organization members to

share knowledge. For example, a common lexicon exists between a software developer

and marketing consultant if they use the same words, expressions, and analogies to

understand problems and solutions. A common lexicon can help organization members

focus on solutions and break down tasks requiring input from multiple areas of expertise

(Majchrzak et al., 2011). Organization members must speak the language associated with

others' area of expertise to effectively share knowledge. The diverse knowledge held by

organization members becomes accessible and valuable when organization members are

able to speak the language of others' area of expertise (Kellogg et al., 2006). Building a

common lexicon eases communication between organization members by providing an

understanding of the nuances of the knowledge shared (Galison, 1997). Organization

members are able to clearly share knowledge when the existence of unknown words and

expressions are minimized. As organization members develop a common lexicon the

chance for miscommunication and conflict to emerge is reduced (Majchrzak et al., 2011).

Developing a common lexicon gives organization members the freedom to engage in

problem solving instead of trying to interpret what others are communicating. This leads to the following hypothesis:

H₆: A higher degree of common language use between two organization members is likely to increase the quality of their knowledge sharing.

Goal challenges. Organization members who develop shared interpretations in addition to perspective taking, understanding a concept from an alternative point of view, have been found to ease knowledge sharing (Bechky, 2003). Shared interpretation of information between organization members limits conflicts and ease knowledge sharing because uncertainty and ambiguity between organization members are reduced (Oborn & Dawson, 2010). A large body of research has focused on how objects, such as repositories, standardized forms, and charts, can be used to facilitate knowledge sharing. Organization members have been found to use objects to streamline differences in interpretation (Carlile, 2002; Star & Griesemer, 1989; Swan et al., 2007). The objects are used by organization members to develop shared interpretations. For example, Faraj and Xiao (2006) found that organization members use co-created documentation to insure similarity in interpretation of information, while Orr (1996) showed how storytelling can be used to create a shared interpretation of work tasks. A central finding across the research focused on objects is that shared interpretation and development of common ground helps facilitate knowledge sharing. Organization members who have a common interpretation of information have an easier time engaging in knowledge sharing.

Building upon the awareness of differences in interpretations, organization members are able to develop a common ground for knowledge sharing. Having a common interpretation of information between organization members help the

cogeneration of ideas, negate conflicts, and reduce the need for elaborations (Majchrzak et al., 2011). For example, organization members that share a common interpretation are more likely to agree on how to solve a problem while recognizing and incorporating the expertise each organizational member hold (Kellogg et al., 2006). As such, organization members ease knowledge sharing by being aware of differences in interpretation but also by co-creating shared interpretations of information. Having a common interpretation of information eases knowledge sharing between organization members by allowing organization members to focus on solving the task at hand. This leads to the following hypothesis:

H7: A higher degree of common interpretation between two organization members is likely to increase the quality of their knowledge sharing.

Work practice challenges. Organization members must go beyond awareness of differences in work practices in order to successfully share knowledge (Bechky, 2003; Carlile, 2002). Awareness of differences allows organization members to mitigate points of conflict, however, to realize the full potential of knowledge sharing organization members must develop common interests and practices (Bruns, 2013; Levina & Vaast, 2008). Identifying similar interests and work practices provide organization members with the basis for seeking out aligned interests and developing common work practices. For example, Hayes and Fitzgerald (2015) found that time spent identifying and documenting common work practices decreased the likelihood of miscommunication between organization members. By developing common work practices organization members are able to not only create routines that mitigate issues of miscommunication but also ease knowledge sharing by building new work practices that are mutually

beneficial. When common interests and work practices are created organization members are more likely to take advantage of others' knowledge, as common work practices between organization members ease knowledge sharing.

Organization members' joint engagement in common tasks is a key way to create common work practices (Levina & Vaast, 2008). As organization members work jointly together a feeling of belonging is formed (Wageman, 1995) while the chance of conflict to emerge is reduced (Yuan et al., 2009). For example, a software developer initially sees a marketing employee as only interested in creating a fancy marketing campaign while not caring about the product. As the two organization members work together common interests may be revealed that creates a feeling of team spirit. Common practices lead organization members see each other as more supportive and understanding of challenges (Levina & Vaast, 2008). Organization members who see each other as supportive are more likely to share knowledge (Wageman, 1995). As such, developing common work practices facilitate knowledge sharing between organization members by reducing the chance of conflict and miscommunication. This leads to the following hypothesis:

H8: A higher degree of common work practices between two organization members is likely to increase the quality of their knowledge sharing.

Awareness of Difference, Common Ground, and Knowledge Sharing

In the previous section numerous hypotheses were proposed. This dissertation aims to understand the type of communicative relationships between organization members that facilitate knowledge sharing by examining their co-occurrence. The co-occurrence between communication relationships is referred to as multiplexity in social network analysis and can be statistically tested (Wasserman & Faust, 1994). Central to

the hypotheses is the distinction between the concepts of common ground and awareness of difference. Awareness of differences may be sufficient for effective knowledge sharing, while common ground between organization members is helpful but unnecessary. Each concept is seen as consisting of three dimensions; differences in language, interpretation, and work practices between organization members (Kotlarsky et al., 2012). This dissertation tests the multiplexity between each of the hypnotized communicative relationships. Table 1 provides an overview of the proposed hypotheses and theoretical mechanisms that underlay them. The following chapters breaks down the data collection and methods used to answer the research question and test the hypotheses.

Table 1

Hypotheses and Overview of Multiplexity in Knowledge Sharing Networks

Model	Com. Element	Mechanism	Associated Citations
Observed Network	Knowledge sharing	The interpretations and evaluations of information shared between organization members	Davenport & Prusak, 2000
H1	Familiarity between organization members	Interaction and exposure between two organization members lay the foundation for relationships	Cummings & Kiesler, 2008; Yuan, Fulk, Monge, & Contractor, 2009
H2	Reciprocated Knowledge Sharing	Organization members that engage each other are more likely to identify other's areas of expertise	Kuhn & Jackson, 2008; Orlikowski, 2002
	Language	Mechanism	
H3	Awareness of difference in language	Awareness of differences in language ease knowledge sharing between organization members	Edmondson & Nembhard, 2009; Okhuysen & Bechky, 2009
H6	Common language	Common language ease knowledge sharing between organization members	Galison, 1997; Kellogg, Orlikowsk & Yates, 2011
	Interpretation	Mechanism	
H4	Awareness of difference in interpretation	Awareness of differences in interpretation ease knowledge sharing between organization members	Hargadon & Bechky, 2006; Kotlarsky, Hooff & Huysman, 2012
H7	Common interpretations	Common interpretations ease knowledge sharing between organization members	Faraj and Xiao, 2006; Oborn & Dawson, 2010
	Work Practices	Mechanism	
H5	Awareness of difference in work practices	Awareness of differences in practice ease knowledge sharing between organization members	DiBenigno & Kellogg, 2014; Jarvenpaa & Majchrzak, 2008
H8	Common work practices	Common practices ease knowledge sharing organization members	Bechky, 2003; Levina & Vast, 2008

Chapter 3: Data and Methods

"It is only through empirical engagement with our focal phenomena that we are able to derive the insights that truly provide value to the organizations we study. And while the methodologies that we traditionally employ in pursuing those insights have served and will continue to serve us well, there is a growing sense that our methodological approaches need to adapt to the growing complexities of the phenomena we study." – Molina-Azorin, Bergh, Corley, and Ketchen (2017, p. 179)

This dissertation takes a mixed methods approach to understand the communicative relationships that ease knowledge sharing. A mixed methods approach embraces the interdependence between quantitative and qualitative research by using multiple methods in data collection and analyzation (Creswell & Clark, 2007). The goal of mixed methods research is to reach a comprehensive understanding of an issue by examining it from varies perspectives (Myers, 2014). In doing so a mixed methods approach includes an inherent encouragement to include multiple epistemological paradigms and theoretical frameworks (Feilzer, 2009). As such, a mixed methods approach often includes research questions as well as hypotheses with the aim to interrelate data and triangulate findings against one another (Myers, 2014). The mixed methods approach is used to validate, inform, and expand upon the results obtained from each method (Creswell & Clark, 2007). In this dissertation data from a survey focused on collecting social network and demographic data, semi-structured interviews, and observations from fieldwork are analyzed, each offering a unique angle to understand how awareness of difference and common ground ease knowledge sharing within the focal organizations. For example, content analysis coding is used to examine the nature of ties that organization members described in their interviews, while quadratic assignment procedures and exponential random graph modeling are used to test the statistically association between the networks and the influence of actor attributes on the

formation of network ties. In aggregate, these different data points provide a qualitative and quantitative understanding of knowledge sharing patterns and behavior.

Neither the quantitative nor qualitative methodological approaches take precedent over one another, as each type of data allow for complementary explanations that help corroborate results. The aim of this mixed methods approach is to triangulate and converge on findings between the observational, interview, and survey data (Rossman & Wilson, 1985). More concretely, the statistical likelihood of multiplex relationships and knowledge sharing is examined, while simultaneously exploring the routines, norms, practices, and content of interactions surrounding knowledge sharing. As such, a social network perspective is used in the collection and examination of qualitative and quantitative data. The qualitative methods expand upon the findings of the quantitative findings by examining the content of communication that surround knowledge sharing. The social network and content analysis both focus on the relational mechanisms that facilitate knowledge sharing.

Using content analysis, quadratic assignment procedures, multi-level models, and exponential random graph modeling aligns with a knowing perspective because these approaches place the emphasis on the dyadic interactions between organization members. The content analysis focuses on the interactions between organization members, QAP analyzes the correlation of variance at the dyadic level between organization members, multi-level modeling takes into account nesting in the dataset at the alter and organizational levels, while ERGM builds upon QAP by allowing the inclusion of high-level network configuration and attributal factors in analyses trying to understand what impacts the formation of dyadic ties. By placing focus on dyadic and communicative

interactions between organization members, the unit of analysis swings from the organizational member, toward the organizational member's interaction with others. In this regard, organization members are often part of multiple projects and their associated teams. Organization members can be involved in multiple projects that each have their own unique configuration of members (Jarvenpaa & Keating, 2011; Kotlarsky et al., 2012). Due to organization members' engagement in multiple teams, it is hard to clearly distinguish team contexts. However, dyadic interactions are the foundation of teams and collaboration in the workplace, as communicative interactions between organization members allow the coordination needed to complete shared goals (Child & Shumate, 2007). The unit of analysis is thus the dyadic relationships that exist between organization members. To examine the multiplex relationships between organization members, data were collected using surveys, interviews, and observations. The survey captured network data that was converted into a sociomatrix by using a roster list method. QAP and ERGM was used as to examine the likelihood of dyadic relationships to co-exist, e.g. the statistical association between knowledge sharing and common language use, that exists between organization members (Robins, Pattison, Kalish, & Lusher, 2007; Robins, Snijders, Wang, Handcock, & Pattison, 2007). Similarly, the content analysis of the interview data allowed for the identification of relational themes surrounding knowledge sharing relationships. The interviews were conducted using a semi-structured interview protocol and transcribed for analysis. The transcribed interviews were examined line-by-line in an effort to identify emerging themes regarding the routines, norms, practices, and content of interactions that organization members saw surrounding knowledge sharing (Glaser, 1998; Krippendorff & Bock, 2009). Data was collected via

in-person observations, semi-structured interviews, and online surveys techniques at three

organizations providing knowledge-intensive services.

Research Context

The three organizations that participated in the research study all provide

knowledge-intensive services to their clients, including software development, design,

and financial brokering. Initial contact with the organizations was conducted through a

company representative that also acted as a champion for the research. Representatives

from each organization reviewed the informed consent protocol, provided letters of

cooperation, and introduced the researcher to the organization. For example, one

champion provided names for organizations members in different offices while another

setup a lunch meeting to present the research to everyone in the office. After initial

engagement with the organizations, the researcher was given the option of coming and

going to each organization with prior notification. Recruitment of person specific

observations, interviews and surveys were conducted through email with informed

consent given on the day of the observation and interview or at the start of the online

survey. Contact information of the participants were provided by the organizational

representative through a roster list containing names, emails, and titles. Table 2 provides

an overview of the main characteristics of each company and is followed by a description

of each organization in detail.

Table 2

Comparison of Participating Companies

Characteristic	Alpha	Bravo	Charlie
Industry	Software Development	Product Design	Financial Services
Work Arrangement	Geographically Dispersed	Co-located	Co-located
Location	Midwest US, Northeast US, Southeast US, and Philippines	Northeast US	Northeast US
Size	26	17	12
Survey Respondents	20	12	9
Interviewees	10	7	3

Enterprise Software Development. Alpha (company pseudonym) was created in

the early 2000s with a focus on the development of enterprise software solutions that

increase patient engagement. The company sells enterprise solutions to enhance customer

and patient engagement in the healthcare industry. The company consists of 26

employees who are mainly located on the East Coast of the United States. However,

several employees work remotely from offices across the United States and Asia. Remote

workers primarily consist of salespeople, managers, and software developers. The health

content creators and project managers are collocated at an office on the East Coast. A

second office is located within a two-hour drive and is used by Alpha as the technology

center where efforts are coordinated between developers and project managers.

Developers in Asia work with a delayed schedule so as to work at the same time as their

American counter parts. Employees take on roles such as project manager, heath content

creator, graphic designer, developer, and administrator. The work includes the creation of patient engagement material and expanding the digital platform that automatically provide information to patients signed up. Alpha is an organization that embraces telework as an integral part of their organizational structure for management and developers while utilizing collocation for content creators. Telework allows distributed organization members to work together and for the company to interface with clients.

Medical Device Design. Bravo (company pseudonym) is a design company located on the East Coast of the United States, which specializes in the design of medical devices. The company was founded in the late 1970s and has designed approximately 400 products that include surgical tools, diagnostic instruments, and laboratory equipment. Clients include Fortune 100 companies in the medical and life science industries. The company has 18 employees that work as project managers, user experience and human factor researchers, industrial designers, and mechanical engineers. The employees job functions include the organization of project workflows, prototyping using computer aided design tools, and optimization of user experiences. The design and engineering process at Bravo is supported by two managers and two administrators. The employees work together from idea to the creation of functioning hardware that can be mass produced. The hardware is focused on enterprise solutions in the life sciences and often includes software components, such as telecommunication or medical examination functionality.

All employees except one are collocated at the same address and all employees work fulltime except for the administrators who work part-time. Bravo is an organization that is experienced in designing complex products based on client's intellectual property.

Each project is staffed with designers, human researchers, and engineers. In this regard, engineers often act as project leads. Organization members work collaboratively on projects. For example, a designer coordinating with an engineer about the size requirements of the mechanical components in the product as to gauge the freedom in design choices. In general, employees join in on a project more intensely at different stages of the design process and often work on multiple projects at the same. Weekly status meetings are used to distribute workload among the employees for the upcoming weeks.

Financial Brokerage Firm. Charlie (company synonym) is an independent and no-conflict institutional agency and brokerage firm specializing in equities. The firm is best known for its practices to circumvent losses to high frequency trading at the behalf of institutional partners. As such the company does not deal with financial services aimed at individual consumers. The company has 12 employees with one fulltime compliance officer, three part-time administrators, and seven brokerage traders. The compliance officer and administrators insure regulatory compliance through monitoring, documenting, and billing the trades. All employees are collocated on the East Coast of the United States. The employees use a single long desk for all the traders with administrators located in close proximity. The traders receive orders from institutional clients that they execute on the stock market. The orders come through secure software systems with phone call and instant messaging often used for clarifying questions to clients. The traders fulfill orders from clients individually but rely on other traders throughout their work day. For example, a trader might ask for someone to monitor his or her orders while going to the bathroom. Office conversations focus on events that might

be impacting any active trades or the market. Charlie is a family-oriented company; four of the employees have close family ties to one another.

Quantitative Data

Data from each organization was used as the basis for the social network analysis. The quantitative data was captured using the online survey software Qualtrics. The survey captured the communicative interactions, perceptions, and knowledge sharing between organization members, in addition to demographic and organizational information. The survey was sent to organization members in order to map the multiplex relationships between knowledge sharing and the perceptions of awareness and common ground in language, interpretation, and work practices between participants. An organizational representative for each company reviewed the survey instructions and questions that could be intangible in the organizational context.

The online surveys captured social network data at the dyadic level in each organization. Rosters were used to capture the relationships between participants. The roster consisted of a list with current organization members' name, email, and title. The roster method was used as it has shown to produce a more accurate assessment of the relational ties between subjects (see e.g. Wasserman & Faust, 1994). The collected data contained an edge list structure. For example, the extracted CSV file from Qualtrics contained the column ego ID followed the ego's response to each identified alter (ego |alter1-q1 | alter1-q2 | alter$N$-qN). The data was transformed by moving alter columns so as to create sociometrices (e.g. ego | alter1-q1 | alter2-q1 | alter$N$-qN). Matrices were used for whole network methods while edge lists where used for factor analysis and multi-level modeling. The presence of a tie was recorded with Likert scales that indicate the

intensity of the relationships and perceptions. The dataset therefore contains valued and directed network ties. For example, a tie between A and B (A -> B) would be recorded if A indicated that she had either hourly, daily, weekly, monthly, or yearly interaction with B. Before each question an instruction was given for participants to follow. The instructions aimed at specifying which relationship was discussed and how the questions and answers should be approached.

Identifying Knowledge Sharing Relationships. Each participant responding to the survey was first asked to identify those organization members that they turned to for knowledge. A list of all organization members was provided to the participants. The participants were asked to select those employees they engaged with in knowledge sharing using a checkmark list. The responses were directed and binary network ties. The participants was asked to "identify the colleagues that has been the most important source of knowledge and expertise, whom you approach if you have a work-related issue or when you want advice on a decision you have to make" The question was designed to be broad and inclusive in capturing potential knowledge sharing based relationships between organization members and such referred to both knowledge, expertise, and advice while limiting the relationships to work contexts. The question was based on prior scales by Tsai (2001) and Cummings and Kiesler (2008). The question served to minimize participants being overwhelmed by an exponentially expanding list of questions for each possible relationship, while not putting limitations on the options of the participants. Thus, the survey was built with a skip logic so that the identified dyadic relationships in the roster list checkbox automatically lead to probing questions about the relationship. The strength of a tie was associated with the Likert scale responses to survey questions.

The assumption of the approach is that a whole network is being captured. The whole

network is created by integration of the identified personal networks of each

organizational member. The lowest response rate across the organizations were 70%. The

data must therefore be treated as dependent, as organization members influences each

other within an organizational context. Additionally, the relationships captured represent

only those alter ties that was grounded in knowledge sharing relationships between

organization members. The edge list therefore provides information about the

communicative ties that surround strong knowledge sharing. Whole and ego-based

network methods are therefore used to understand the ties surrounding strong knowledge

sharing relationships between organization members. The following section describes

how the relational ties were sought captured.

  Knowledge sharing. To capture the knowledge sharing between organization

members in-depth, three Likert scale items was provided for each identified

organizational member. The combination of the items corresponds to the ability of the

shared knowledge to improve tasks, be easily understood, and provided in a timely

manner. The questions are based on prior research (Cummings & Kiesler, 2008; Faraj &

Sproull, 2000; Tsai, 2001; Yuan et al., 2007) but adapted to the context of the

participating organizations. In doing so the questions do not ask directly about the sharing

of knowledge across pre-identified domains of knowledge but about the quality of

knowledge sharing between organization members. For each identified organizational

member, the participants were asked to describe the relationship using five-point Likert

scales. Participants were asked to indicate the degree to which "The knowledge and

expertise provided to me helps improve my work", "I can understand and put into action

the knowledge and expertise provided to me", and "I am able to reach out to get knowledge and expertise when I need it" for each identified tie.

Familiarity. To understand how knowledge sharing ties are formed between organization members, it is important to examine the fundamental foundation that knowledge sharing relationships rests on. Familiarity between two organization members can be operationally defined as the amount of interaction and exposure between two organization members (Cummings & Kiesler, 2008). The use of the concept of familiarity over other measures such as frequency of communication was done to place emphasis on the material aspects of communication such as organization members being in the same room or attending the same teleconferences without directly interacting. Relational ties are formed on the basis of more than verbal communication. A distinction was made between text and audio/video-based communication based on observations prior to survey deployment and feedback from the participants. Organization members thought of communication technologies as belonging to either group. For example, a change was made based on observation and engagement with the organizations, as screen capture tools were a central tool for remote workers at Alpha. Across both Alpha and Bravo audio and screen capture features was the primary tool of communication with clients. Organization members would use a shared screen and digital conference calls to interaction with clients or a remote employee. Collocated organization members would use the instant messaging tool Teams to send short messages or send an email with a pdf before going to a colleague asking for feedback. The survey was changed to include screen capture tools as an audio/video-based communication technology as it brought organization members together through client facing activities. Based on previous

operationalization (Cummings & Kiesler, 2008), participants were asked to identify on a scale ranging from hourly to yearly: "How often do you talk in-person?", "How often do you find yourself in the same room?", "How often do you use text based technologies to communicate, e.g. using email/Messenger/Slack?", and "How often do you talk use audio/video technologies to communicate, e.g. telephone/Skype/Teams/Zoom/screen-capture tools?"

Awareness of differences. To examine and map the awareness of differences in language, interpretations, and work practice between organization members, three five-point Likert scale items were deployed. The questions are based on Kotlarsky et al. (2012) knowledge boundary scales but adopted to inquire about awareness of difference. To identify awareness of differences in language use participants are asked to reflect upon their interactions with a certain other and asked "I notice and think about differences in the words and expressions used", "I notice and think about differences in goals and interest", "I notice and think about differences in workflows and habits" The Likert scale ranged from strongly agree to strongly disagree.

Common ground. To map the degree to which organization members have developed a common ground around language, interpretations, and work practices, three five-point Likert scale items were deployed. The questions are based on Kotlarsky et al. (2012) knowledge boundary scales but adopted to inquire about commonalities between organization members. To identify common lexicons participants were asked "We often use the same words to describe problems and ideas?". To examine the common interpretations of organization members, participants were asked "We often have similar ways of interpreting and thinking about work related issues?". Lastly, for work practices,

participants were asked "We often have similar ways of working and approaching problems?".

Control Variables. Organization members' gender, tenure, and hierarchical position have been found to influence knowledge sharing (McEvily, Soda, & Tortoriello, 2014; Singh, Hansen, & Podolny, 2010). To take into consideration homophily effects, that organization members are more likely to ties with similar others, gender is included as a categorical control variable. Gender is operationalized as either male, female, or other. No participant across the three organizations selected the other category. As such, the measurement was treated as a binary variable. Similarly, power that comes from hierarchical position and tenure can play an important role in what counts as knowledge and how knowledge is shared between organization members (Oborn & Dawson, 2010). Hierarchical position is operationalized as a categorical and binary variable. Participants was asked to indicate whether they had management responsibility over other employees or not. Tenure is captured using a ratio variable based on years spend at the company and in the industry. For the geographically dispersed company Alpha, employees indicated their location. Geographically dispersed employees have been found less likely to interact than collocated employees (O'Leary & Cummings, 2007). The location information was used to generate a network with ties between employees operationalized as distances in miles.

Social Network Analysis. The following section highlights and assesses the results of a data quality review, factorial analysis, quadratic assignment procedures (QAP), exponential random graph models (ERGM), and multilevel regression models. Using both whole network and ego-based models requires two separate datasets. One

dataset was needed for whole networks in sociometrix format, and a second dataset was needed in an edge list format for ego-based analytics. The raw survey data contained the dyadic relationships between organization members – rows containing ego characteristics, ego ID, alter IDs, and the strength of the ties. The relational information in the data was separated into an edge list format. To understand the risk posed by missing data the function *missmap* from the R package Amelia (Honaker, King, Blackwell, 2011) was used to establish the degree to which participants had abstained from completing parts of the survey. Figure 1 provides an illustration of the missing data. Participant 63 did not fill out the questions regarding common development and did so deliberately compared to the full completion of another concept measures. As a non-random variation the participant was dropped from the dataset.
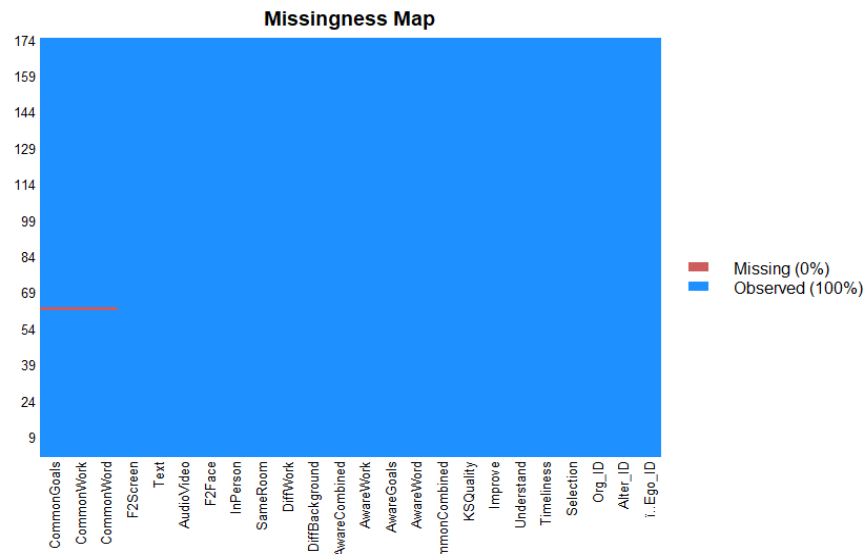
Figure 1. Visualization of missing data. The figure indicates via colored indexes whether a value in the dataset was missing – the number of participants that skipped survey questions.

The edge list captured valued and directed network ties from members of each participating organization. The presence of a tie was recorded using Likert scale items ranging from one to five (Field, Miles, & Field, 2012). The Likert scale responses to questions was used as the weight for the ties included in the descriptive and factorial analysis, multilevel models, quadratic assignment procedures (QAP), and exponential random graph modeling (ERGM) process. For example, a tie between A and B (A -> B) was recorded if A indicates that she has interacted with B, with, for example, the responses to questions about awareness of differences and common ground being aggregated and used as the weight of ties. A strong dependence exists between the identified personal networks as the data was sampled in organizations with sizes smaller than 40. Each organization was therefore operationalized as a whole network.

The edge list data format was used for conducting factor analyses and regression-based models. The factor analyses used a maximum likelihood method to establish the statistical degree to which variables in the study factor together. The results indicate that the measures of this work have captured five unique concepts. Further, this factor loading falls in line with the hypothesized constructs explicated in the prior literature review. Common ground, awareness, and knowledge sharing concepts factor distinctly. However, Table 3 also shows that being in the same room and talking in person should be seen as a separate concept from exposure that happens through text or audio/video-based communication. Together, this gives confidence that the theorized concepts were captured by the measurements in the surveys. In that regard, the uniqueness score of the individual measures was low. This indicates that the concepts are closely related – the variance in the data is weak but falls and rises together following the a priori theorizing.

Table 3

Maximum Likelihood Factory Analysis Showing Factor Results Above 0.5

Variables	Uniqueness	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
CommonWord	0.27	0.76	-	-	-	-
CommonGoals	0.14	0.88	-	-	-	-
CommonWork	0.23	0.83	-	-	-	-
AwareWord	0.33	-	0.79	-	-	-
AwareGoals	0.16	-	0.89	-	-	-
AwareWork	0.35	-	0.79	-	-	-
SameRoom	0.04	-	-	0.95	-	-
InPerson	0.12	-	-	0.89	-	-
Timeliness	0.29	-	-	-	0.53	-
Understand	0.11	-	-	-	0.85	-
Improve	0.14	-	-	-	0.83	-
AudioVideo	0.36	-	-	-	-	0.74
Text	0	-	-	-	-	0.93

The dataset used for the whole network methods (e.g. network statistics, QAP, and ERGM) contained an inherent bias towards strong relationships, as the selection tie was used to narrow down the relationships that participants saw as important for knowledge sharing. The selection tie functions to lessen the burden of participants to identify the intensity of multiple ties among organization members - a bias that is amplified by a response rate a little over 70% across organizations. The organization members who did not respond were treated as non-existing and thus not included in the

dataset. The dataset used for whole network methods contained three sociometrices

(Alpha = 20x20, Bravo = 12x12, Charlie = 9x9) corresponding to the number of

participants that filled out the online survey. The dataset's attribute lists consisted of two

columns each: participant ID and associated attribute value such as gender. The

participant ID was used to match up the sociomatrices and attribute data. No artificial

constrains were placed on organization members' number of responses in the selection

tie, which mitigate some of the strong tie bias in the data.

Several social network analysis methods were used to examine the quantitative

data. The initial social network analysis included ERGM as the primary method of

analysis but multicollinearity was found in the data that prevented a full model from

being tested. Whole network methods, such as QAP and ERGM, were given primacy due

to the dependence of the data but multilevel models were additionally run to better

understand the statistical relationships found in the data. The R environment (Team,

2013) and the *ergm* package (Handcock, Hunter, Butts, Goodreau, & Morris, 2003) were

used to run the social network analyses while the *lme4* package (Bates et. al., 2014) was

used for multi-level models. The following section describes how ERGM, QAP,

multilevel modeling was used to examine the proposed hypotheses.

Exponential random graph modeling. ERGM assess the statistical likelihood of

co-occurrence between ties and how actor attributes influence the existence of ties. In this

case, knowledge sharing in relation to the awareness and common ground between

organization members' language use, interpretation, and work practices. Each

hypothesized relationship and control variable can be tested as parameters (Robins,

Pattison, et al., 2007; Shumate & Palazzolo, 2010). A parameter specifies which

relationships are taken into consideration in the model. In this regard, each parameter also

functions as a control for other parameters in the model (Shumate & Palazzolo, 2010).

The modeling process used in ERGM generates a series of random permutations which

are then used as a point of comparison to determine the likelihood that the configuration

of the given network is statistically significant. ERGM thus allows for an examination of

the statistical association between knowledge sharing and organization members'

engagement in communicative interactions. A model that does not converse is a sign that

the included parameters do not accurately describe the observed network. The series of

random permutations generated do not match the observed network (Shumate &

Palazzolo, 2010). A way to see if the inclusion of parameters improves the ERGM is by

examining the AIC and BIC measure provided in the summary statistics of the model.

Parameters that help describe the observed network decreases the AIC and BIC scores.

Ultimately, the ERGM process did not yield the successful development of a

converging model that includes all the theorized relationships. In the following section a

detailed description is provided of the steps taken to build functioning ERGMs. Table 2

provides examples of the models that have been tested. The models were tested on

network data from each organization with the observed network being the directed and

valued knowledge sharing network. The standard practice when building ERGMs is to

first include baseline parameters that help describe the underlaying network structures,

such as the tendency for ties for be formed (*edge* parameter), the existence of reciprocity

(*mutual* parameter), and the degree to which clusters form (*transitivity/gwesp*

parameters). Models that only included the baseline parameters were able to converge.

To build upon the baseline parameters both attribute and multiplexity parameters were tested. To test for multiplexity between networks the *edgecov* parameters was used. An *edgecov* parameter tests whether the variance in valued dyadic ties of one network are likely to co-vary with the valued dyadic ties of another network. Models that included edgecov parameters did not converge. Table 2 shows how models with *edgecov* parameters did not converge, while models that only included attribute focused parameters were able to converge. Models that included *edgecov* parameters returned errors that indicated that the model either had an insufficient sample size or highly correlated model parameters.

To test whether the errors were the results of an insufficient sample size, the network data from company Alpha, Bravo, and Charlie were combined. The merging of the network data resulted in a 55 by 55 matrix ($n = 55$) with directed and valued ties. Any interpretation of the results from the combined network data must be done with caution, especially regarding high level network configurations. Higher level parameters, such as transitivity, would be impacted by the merging of three unconnected networks. The tested models aimed to test the multiplexity at the dyadic level and thus the combination of networks posed less risk of misinterpretation. However, models using the combined network data returned errors that suggest an insufficient sample size or highly correlated model parameters. A sample size of 55 can generate up to 1485 ties between organization members. As actors are added to a network, the potential ties between actors grows exponentially (Wasserman & Faust, 1994). The focus on dyadic ties between actors gives robustness to network analyses. For example, Palazzolo (2005) have applied ERGM-type models, to teams ranging from 8 to 20 in size, suggesting that despite the limited sample

size there are sufficient data for the analysis. This suggest that it is not sample size or the building of the models themselves that lead to the non-convergence of the models. The factorial network analysis suggested that the variance across variables clustered around five concepts; knowledge sharing, awareness, common ground, face-to-face communication, and technological-based communication. This follows the theoretical concepts, with the exception of the treatment of the familiarity variable, where variables are clustered around two factors: geographical proximity and technological interactions.

Table 4

Matrix of the Product-Moment Correlation Between Networks

Networks from Company Charlie

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	KS_Improve															
2	KS_Understand	1														
3	KS_Timeliness	1	1													
4	Aware_Language	0.94	0.94	0.94												
5	Aware_Interpretation	0.94	0.94	1	1											
6	Aware_Work	0.94	0.94	1	1	1										
7	Common_Language	0.98	0.98	0.96	0.96	0.96	0.96									
8	Common_Interpretation	0.98	0.98	0.96	0.96	0.96	1	1								
9	Common_Work	0.96	0.96	0.94	0.94	0.94	0.98	0.98	0.98							
10	Fam_InPerson	1	1	0.94	0.94	0.94	0.98	0.98	0.96	0.96						
11	Fam_SameRoom	1	1	0.94	0.94	0.94	0.98	0.98	0.96	1	1					
12	Fam_Text	0.9	0.9	0.84	0.84	0.84	0.88	0.88	0.86	0.9	0.9	0.9				
13	Fam_AudioVideo	0.86	0.86	0.8	0.8	0.8	0.85	0.85	0.82	0.86	0.86	0.95	0.95			
14	DiffBackground	0.98	0.98	0.96	0.96	0.96	1	1	0.98	0.98	0.98	0.88	0.85	0.85		
15	DiffWork	0.98	0.98	0.96	0.96	0.96	1	1	0.98	0.98	0.98	0.88	0.85	1	1	

To analyze the network data containing multicollinearity and test the multiplexity hypotheses (Hypotheses 1 and 3 to 8), quadratic assignment procedures (QAP) were run using the *netlm* function in R. QAP provides an assessment of the structural similarity between networks at the dyadic level and was developed as a response to the type 1 error bias found in product-moment correlations between networks (Krackhardt, 1988). Unlike product-moment correlations, which assumes observations are independent and identically distributed, QAP takes into consideration the dependence between data points (Krackhardt, 1988). For instance, the actors in a network have dyadic ties that imply a potential dependent relationship between the directly or indirectly connected organization members. Therefore, the assumption of traditional ordinary least squares regressions does not hold true.

QAP regressions use nonparametric permutations similar to ERGM. After repeating permutations, the method can test the null hypothesis of the regression by comparing generated and observed networks. QAP allows to test whether there is similarity in the structures of between networks at the dyadic level. The test examines if variance between dyadic ties in one network correlates with the variance between dyadic ties in another network (Krackardt, 1987). A special permutation method called semi-partialling plus (QAPSPP) was used due to the multicollinearity in the network data. QAPSPP is limited to interval and ratio network data, which the captured network data in this dissertation contains, but have shown ability to deal with multicollinearity (Dekker, Krackhardt, & Snijders, 2007).

To capture a fine-grained understanding of the association between networks at the dyadic level, QAPSPP models were create for each of the captured network variables.

Each type of network was tested against each other and results was reported as a matrix of the R-squared values of each model, the associated p-value, and direction of the estimated coefficient. The results provide a matrix of the association between networks, and thus provide an indicator of the degree to which variance in the dyadic ties in one network varies with the variance in another network. The network association matrix answers hypotheses testing whether multiplexity exists at the dyadic level between the ties of knowledge sharing, awareness of difference, common ground, and difference in backgrounds and work.

The generated matrix from the QAP tests therefore consists of the association between knowledge sharing, awareness of difference, common ground, and control networks. In addition, a network with randomly generated values (ranging from 1 to 5) was included in the network association matrix to ensure that the method and data were responding as expected. The tests were run on data from each of the participating organizations. To support hypotheses of covariance between networks, the results of the QAPSPP tests were expected to have a positive and statistically significant association between the variance at the dyadic level for each of the networks.

Hypothesis one was tested by comparing measures of communication frequency with the measure of quality in knowledge sharing ties. Hypothesis three was examined by comparing the awareness of difference in language use measure with the measure of quality in knowledge sharing ties. Hypothesis four was investigated by comparing the awareness of difference in interpretation measure with the measure of quality in knowledge sharing ties. Hypothesis five was tested by comparing the awareness of difference in work practice measure with the measure of quality in knowledge sharing

ties. Hypothesis six was examined by comparing the common ground in language use measure with the measure of quality in knowledge sharing ties. Hypothesis seven was tested by comparing the common ground in interpretation measure with the measure of quality in knowledge sharing ties. Hypothesis eight was inspected by comparing the common ground in work practice measure with the measure of quality in knowledge sharing ties. It is expected that there is co-variance in the dyadic ties of the knowledge sharing, awareness of difference, and common ground network ties. Thus, the QAPSPP models were expected to indicate a positive estimated coefficient, high r-squared values, and a p-value of 0.05 or lower. Table 4 provides an overview of each hypothesis, the analytic method applied, and the source of the data.

To test hypothesis two and supplement the QAP method, ERGMs were run for each company. Hypotheses two propositions that knowledge sharing ties are likely to be reciprocated by organization members. ERGM examines the effect of attributes on the formation of ties and the degree of reciprocation between organization members in the observed networks that cannot be included with QAP. Identical models were built for each of the participating organizations with aggregated knowledge sharing network measures used as the observed network. The parameter *mutual* was included to test the existence of reciprocity in the knowledge sharing network, and thus test hypothesis two. The parameters *nodematch* was included to take into consideration that organization members of the same gender and hierarchal position would be likely to form knowledge sharing ties with each other. *Nodematch* tests whether actors with similar nodal attributes are likely to form ties with each other. Similarly, the *nodeocov* parameter was included to test whether organization members' tenure at the company or in their industry impacted

the formation of knowledge sharing ties. The *nodeocov* parameter tests outgoing ties and thus represent organization members' own perception of their communicative interactions with others. The use of outgoing ties was selected because the network data is directed and based on organization members own perception.

In each attribute focused ERGM, a baseline was included to control for the general tendency of tie formation and transitivity to exist in the network (*edge* and *gwesp* parameters). These measures were included to take into consideration the dependencies between actors in the network and their impact on formation of knowledge sharing ties between organization members. This follows standard practice of controlling for dependence in ERGM (Robins et al., 2007; Shumate & Palazzolo, 2010). The combination of QAP and attribute focused ERGMs was utilized to uncover the multiplexity in the data, the degree of reciprocity in the knowledge sharing networks, and testing the impact of control measures on the formation of knowledge sharing ties.

To support the QAP results and to provide additional insight to the statistical relationships between the concepts, a multilevel regression model was developed. A multilevel model takes into consideration how the ego network data is nested within alter ties and organizations (Snijders, Spreen, & Zwaagstra, 1995). The method is primarily applied in settings where the dependence between data points stem from larger and dispersed social environments (Vacca et. al., 2018). Thus, aggregated data from the three organizations was used as the basis for the analysis. Multilevel models can help understand hypothesis 1 and hypotheses 3-8 by examining how knowledge sharing ties are explained by the existence of common ground, awareness, and exposure ties. The fact that observations from the same organizational member are clustered around egos and

their organizations requires dependence to be taken into consideration when running regression models. A multi-level model adds parameters that control for clustering in the edge list dataset – adding structure to the error term of an ordinary least squares regression (Vacca, 2018). A significant and positive statistical relationship would suggest that ties are co-occurring among organization members – knowledge sharing ties are predicted by common ground, awareness, and exposure ties. Together the QAP and multilevel results helps understand the statistical relationships in the observed data – the degree to which variance in the knowledge sharing, common ground, and awareness tie measures co-vary.

Qualitative Data

The qualitative data consists of observations and interviews. The observations were used to understand everyday work practices while functioning to inform the interviews and quantitative survey components of the research. Observations impacted the phasing of concepts in the surveys and provided prompts about participants specific behavior in the interviews. Interviews were transcribed and analyzed in a content coding software program (Dedoose, 2016, Version 7.0.23). Analysis of the interview data followed two iterative coding stages. Each stage was focused on the relational aspects of knowledge sharing. The first stage was aimed at identifying and expanding the number of themes identified in the data, while the second stage focused on compressing themes into fewer unified categories. The steps were dynamic and iterative.

Observations. Observations can work to supplement and inform the interview (Lofland, Snow, Anderson, & Lofland, 2006). As part of the study, the researcher got access to come and go at the participating organizations. Observations therefore consisted

of observations made from the perspective of a collogue – a distant observer. Additionally, observations were conducted from a closer perspective. The researcher shadowed employees as they went about their everyday work (Czarniawska, 2007). Shadowing of participants were done by following participants as they interacted with others and engaged in their planned schedule. Notes was taken on the type of conversations they had, who they communicated with, and how the employees used various technologies to conduct their work. For example, the use of computer aided design tools or trading algorithms to execute a trade order. Observations were used to ask participants clarifying questions about recent interactions and behaviors during interviews. The observations varied from two- to eight-hour blocks of time, two to three times a week, over a four-month period. The organizations were visited over 32 different occasions for more than 150 hours. The researcher was provided free access to each of the organizations but provided prior notice before visits.

      Semi-Structured Interviews. A semi-structured interview protocol was used to guide the interviews with participants. Semi-structured interviews were conducted following an initial period of observation. The interviews were conducted onsite in an area removed from colleagues to insure privacy. A total of 20 interviews were conducted with an average length of 57 minutes and median length of 59 minutes. The longest interview went for 80 minutes and the shortest lasted 34 minutes. The interviews were structured around three themes and focused on the participant's relationships with colleagues. Prior observations were used as prompts for questions throughout the interview. The first theme of the interview was centered around understanding the role and expertise of the interviewee. The subsequent themes explored the relationships

between organization members. The participants where asked how they approached others to share knowledge, the type of knowledge they shared, and the routines, norms, and work practices that they have formed. The interview protocol can be found as attachment A. Follow-up, probing and interpreting questions were used to facilitate the interview (Kvale, 1996).

Qualitative Data Coding. The analysis of the interviews and observations were carried out recurrently. Theoretical insights, generalizations and reflections were written in the edge of the observational notes and notes was routinely used as prompts for interview questions. Interviews would be transcribed and reread to reflect on themes that could be emerging from the data. The observations reveled work practices that was hard to talk about without prior experience. For example, the awareness of difference and common ground concepts emerged from the theoretical framework of the dissertation, observation of employees, and interviews. The content analysis of the interviews followed the guidelines provided by Krippendorff and Bock (2009) while being inspired by the nuances given by Glaser (1998). The aim was to apply the systematics needed for replication of the content coding process. The interview transcripts were uploaded to the qualitative data analytics software Dedoose (2016, Version 7.0.23). Seeing knowledge sharing as a relational activity influenced how the content analysis was approached. The focus of the content analysis was on identifying themes regarding organization members' knowledge sharing and relationships with others. To goal of the content analysis was to understand the relational factors and situations that impacted knowledge sharing between organization members. Two iterative steps were used to code the data.

In the first step, all interview transcripts were, line-by-line, examined for emerging themes using the a priori determined concepts of employees' work practices, interpretations, and language use. Coded lines included participants discussing the type of communication and the routines, norms, and practices that eased knowledge sharing. The interviews were examined until saturation was reached and no new themes emerged (Glaser, 1978; Glaser & Strauss, 1967). A total of 186 themes were generated and applied 837 times in the transcripts. The aim was to be expansive, with deliberate overlap, in the generation of themes.

In the second step of the coding, the goal was oppositely to identify patterns and connections between descriptions in the data (Corbin, Strauss, & Strauss, 2014; Glaser, 1978; Strauss & Corbin, 1998). Codes that described similar ideas, comparisons, and tensions were grouped together as one theme. In doing so, the commonalities, differences, and relationships between the themes were examined and evaluated with the goal of creating an abstracted understanding of the data through the identification of themes. For example, an identified theme was reviewed and compared with other identified themes to ensure that they were conceptually distinct. Themes that were similar were merged together into a new theme. A total of 33 unique themes were identified containing 551 excerpts. The themes aimed to be mutually exclusive.

The two type steps of content coding formed the basis for a repeated reexamination of themes until a saturation in expansion and reduction of themes were reached. A codebook was kept during the coding process which contained the temporary drafts of definitions and key quotes for each identified category and theme. To ensure the reliability and validity of the content analysis a second coder was used. The codebook

was used as reference for the second coder. Agreement between two coders indicates that the qualitative results were consistent and able to be reproduced by others (Morse, Barrett, Mayan, Olson, & Spiers, 2002). Coder reliability provides a measure of the validity and reliability of the data. Before the second coder started, an initial training session was held to clarify any questions and interpretations of the codebook. The second coder was given a 10 % sample of the data (two interviews) and was asked to identify categories and themes according to the codebook (Lombard, 2004). The results of the second coder were compared to the results from the original coder. Agreement was reached if the coders had applied the same code to the same sections of the interview. Cohen's kappa was used to test the reliability of the coding schema (Cohen, 1960). Cohen's kappa is the proportion of agreement over and above chance alone (Landis & Koch, 1977). A Cohen's kappa of 0.21 is considered poor agreement, between .41 and .61 is moderate agreement, .61 to .81 is good agreement, and a value over 0.81 is very good agreement (Bakeman, 2000). Agreement was found between the first and second coder for the parent codes; language ($k = 0.78$), interpretation ($k = 0.77$), and work practice ($k = 0.85$). A pooled Cohen's Kappa (De Vries, Elliott, Kanouse, & Teleki, 2008) was used to measure the agreement between the two coders across all applied codes, which revealed a high level of agreements ($k = 0.81$). The results of the intercoder reliability test suggest that the coding schema is reliable and valid.

Weaving Quantitative and Qualitative Analysis

The quantitative and qualitative analyses are designed to be complementary. The methods are focused on understanding the interactions and relationships that build strong knowledge sharing ties among organization members. QAP and ERGM tests the degree

to which dyadic structures exists within and between networks, specifically the degree of multiplexity between the networks and the reciprocity of knowledge sharing ties. The content analysis provides an understanding of the context that lies beyond the statistical understanding of the networks. The content analysis explores the type of interactions and practices that help facilitate knowledge sharing. Table 4 provides an overview of the proposed research question and associated hypotheses. Together the analyses aim to paint a picture of the mechanisms that help knowledge sharing to form between organization members.

Table 5

Summary of Research Question, Hypotheses, Data, and Analyses

Proposition	Analytic Approach	Key Data
H1: A higher frequency of communication between two organization members is likely to increase the quality of their knowledge sharing.	QAP & Multi-level Regression	Survey
H2: Organization members are more likely to engage in knowledge sharing with organization members who reciprocate in sharing knowledge than what would be expected by random chance.	Exponential Random Graph Modeling	Survey
H3: A higher awareness of differences in language use between two organization members is likely to increase the quality of their knowledge sharing.	QAP & Multi-level Regression	Survey
H4: A higher awareness of differences in interpretation between two organization members is likely to increase the quality of their knowledge sharing.	QAP & Multi-level Regression	Survey
H5: A higher awareness of differences in work practices between two organization members is likely to increase the quality of their knowledge sharing.	QAP & Multi-level Regression	Survey
H6: A higher degree of common language use between two organization members is likely to increase the quality of their knowledge sharing.	QAP & Multi-level Regression	Survey
H7: A higher degree of common interpretation between two organization members is likely to increase the quality of their knowledge sharing.	QAP & Multi-level Regression	Survey
H8: A higher degree of common work practices between two organization members is likely to increase the quality of their knowledge sharing.	QAP & Multi-level Regression	Survey
RQ: To what degree is awareness of difference and the development of common ground formed around the knowledge sharing ties of organization members?	Content Analysis	Interviews

Chapter 4: Mapping Knowledge Sharing

"Usually when we think of where people turn for information or knowledge we think of databases, the Web, intranets and portals or other, more traditional, repositories such as file cabinets or policy and procedure manuals. However, a significant component of a person's information environment consists of the relationships he or she can tap for various informational needs" – Cross, Parker, Prusak, and Borgatti (2001, p. 100)

This chapter details the findings regarding how awareness of difference and common ground between organization members influence and affect knowledge sharing. As discussed in the previous chapters, awareness of difference between organization members can be seen as sufficient for knowledge sharing. However, common ground may accelerate knowledge sharing. Awareness of difference allows organization members to understand where others are coming from, the language they use to describe problems, the way they interpret information, and the type of deadlines they face. Developing a common ground builds upon an awareness of differences by allowing organization members to create shared terminology that describe issues, to see the same warning signs in provided information, and to be on the same page regarding deadlines. This dissertation posits that awareness of difference is sufficient for effective knowledge sharing but that common ground between organization members can improve the speed and efficacy of knowledge sharing. Common ground is not needed for knowledge sharing but helps improve it.

The quantitative findings are presented in the following section. The quantitative findings are presented first with qualitative results presented in the subsequent chapter. The presentation order builds upon the notion that qualitative findings help explain the results of the quantitative results. The qualitative findings provide context and nuance to the quantitative results (Myers, 2014). It was hypothesized that knowledge sharing ties

are likely to be reciprocated and that multiplex relationships exist at the dyadic level between organization members. When organization members are aware of colleagues' differences, and when common ground is developed, knowledge sharing ties are more likely to be formed. Thus, it is argued that there is a positive and statistically significant co-occurrence at the dyadic level between frequency of communication, awareness of difference, common ground, and knowledge sharing. The quantitative analysis was therefore designed to examine the co-occurrence and multiplexity of ties between organization members by using descriptive network statistics, quadratic assignment procedures, and exponential random graph modeling.

Descriptive Analysis

The initial analyses consisted of an examination of the survey response rates and the descriptive statistics for each of the three companies. Table 5 shows the average response rate for the deployed network surveys. Alpha had the highest response rate at 76.9% ($N = 26$, $n = 20$), while Bravo held a response rate at 70.5% ($N = 17$, $n = 12$). Each company had a response rate of at least 70%, which is considered acceptable for analyses that aim to examine whole networks (Wasserman & Faust, 1994).

Descriptive analyses were run on data for each participating company at both the individual and network level. The descriptive analyses indicated which organization members were selected as the most importance sources of knowledge sharing. Thus, the tested networks were directed and binary. Table 5 provides an overview of the individual level descriptive statistics in the selection networks at Alpha, Bravo and Charlie.

Table 6

Participation and Response Rates

	Roster Count (N)	Participation Count (n)	Response Rate
Alpha	26	20	76.9%
Bravo	17	12	70.5%
Charlie	12	9	75%

The analyses show that the number of selected knowledge sharing ties correspond to the size of the companies. Employees at Alpha, on average, selected 3.9 others as important sources for knowledge sharing, while employees at company Charlie had the lowest selection of others with an average of 3.08 employees. The result indicate that the organization members selected multiple others and thus provided network data that lead to a connected and whole network.

A similar trend was found in the measure of employees' average measure of betweenness centrality. Betweenness centrality measures the number of times an actor is in the shortest path between other actors and is an indicator of degree to which employees act as a bridge in the network (Wasserman & Faust, 1994). The highest betweenness score at Alpha was 125.67 (z score of 3.13) with Bravo tailing at 106.68 (z score of 3.8). The lowest score was found in Charlie with a max of 38 (z score of 2.8). A high score suggests that employees in the network act as bridge between disparate clusters. Thus, the networks at each company is characterized by a few employees acting as bridges between groups of employees. This is supported by a high standard deviation that indicates a negative skew in the betweenness score of employees.

Table 7

Descriptive Nodal Statistics of Knowledge Selection Networks

Alpha	Average	SD	Max
Outdegree of Employees	3.92	4.34	19.00
Betweenness of Employees	16.81	34.68	125.67
Bravo			
Outdegree of Employees	3.83	3.91	16.00
Betweenness of Employees	10.56	25.20	106.68
Charlie			
Outdegree of Employees	3.08	3.20	11.00
Betweenness of Employees	5.25	11.35	38.00

Table 5 and 6 provides an overview of network level descriptive statistics for each of the participating companies. The network level measures reveal that the networks have a relatively low density, with the highest score being less than .30, thus suggesting that employees are selective in the formation of knowledge sharing ties. Density is the degree to which all actors in the network are connected (Wasserman & Faust, 1994). The betweenness centrality of the networks indicate that company Alpha were different from both Bravo and Charlie. The Alpha network had a betweenness centrality of 0.19, which suggest that there are few employees who act as bridges in the network. Thus, suggesting that the network consists of relatively isolated clusters. This notion is supported by the closeness centrality of the network as the network of Alpha has a score of zero. Closeness centrality is an indicator of how close an actor, on average, is to other actors in the network (Wasserman & Faust, 1994). Thus, it can be concluded that company Alpha has

few knowledge sharing ties that are loosely connected and act as bridges between

clusters.

Table 8

Descriptive Network Statistics of Knowledge Selection Networks

Network Level	Alpha	Bravo	Charlie
Density	0.16	0.23	0.28
Transitivity	0.57	0.48	0.51
Centralization (Betweenness)	0.19	0.37	0.32
Centralization (Closeness)	0	0.56	0.70

At the network level, companies Bravo and Charlie had a relatively high

betweenness centrality and closeness centrality score. Bravo has a betweenness centrality

score of 0.37 and a closeness centrality score of 0.56. This suggest that Bravo's network

consists of connected clusters were several employees act as bridges. A similar pattern

can be observed at company Charlie as the network had a betweenness centrality score of

0.32 and a closeness centrality score of 0.70. Compared to Alpha and Bravo, employees

at Charlie are more closely connected.
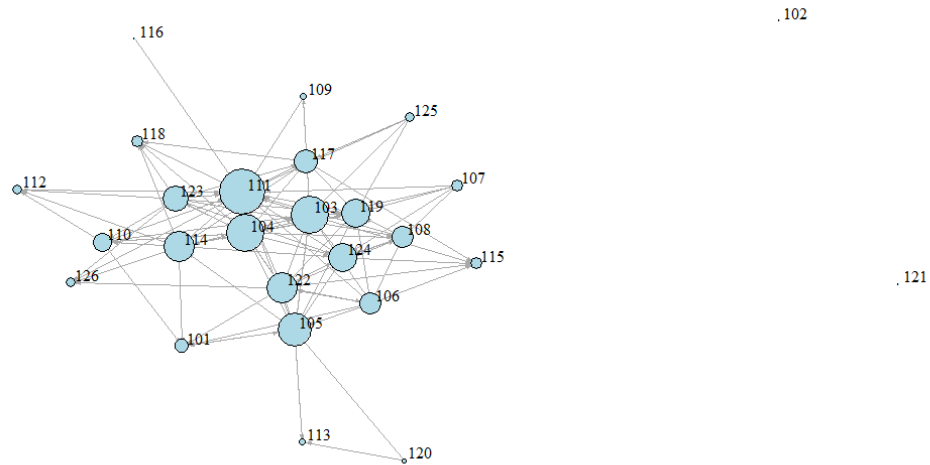
Figure 2. **Network Visualization of Alpha.** The size of a node is based on its outdegree. Lines with arrows indicate a directed and binary knowledge sharing tie between nodes.
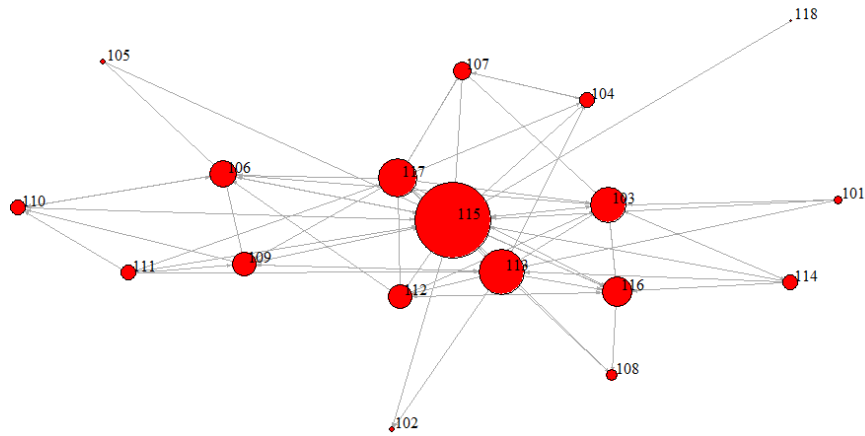
Figure 3. **Network Visualization of Bravo.** The size of a node is based on its outdegree. Lines with arrows indicate a directed and binary knowledge sharing tie between nodes.
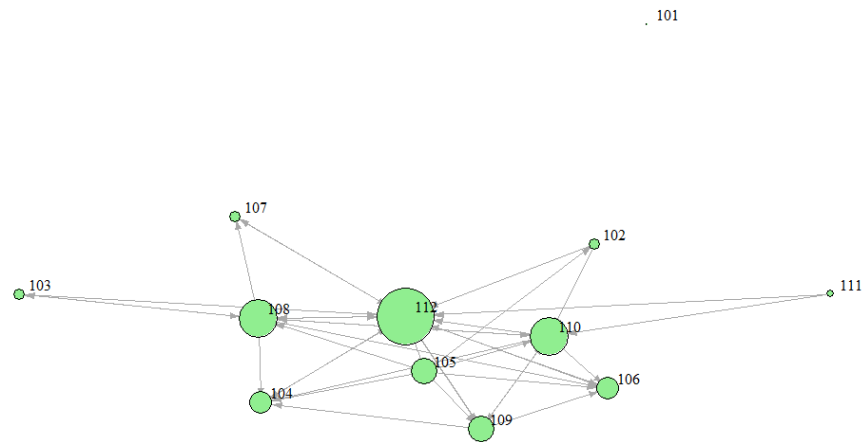
Figure 3. **Network Visualization of Charlie.** The size of a node is based on its outdegree. Lines with arrows indicate a directed and binary knowledge sharing tie between nodes.

Figure 1, 2, and 3 provides a visualization of the selection networks at company Alpha, Bravo, and Charlie. A network consists of nodes and ties, while a network visualization is the representation of nodes and the ties between nodes. Circles are used to represent nodes, while lines between nodes are represented by lines. The visualization illustrates the structure of the networks at each company. The visualization supports the notion that the network at Alpha is relatively disconnected and dominated by employees who act as bridges within the network. Two developers at Alpha indicated that they did not engage in knowledge sharing with others. The visualization also shows how company Bravo and Charlie are relatively closely connected while dominated by one or two employees who act as bridges in the networks. The isolate at Charlie was a administrate assistant that did not engage in knowledge sharing with others.

Social Network Analysis

Figure 4 illustrates how knowledge sharing, awareness of difference, common ground,

and familiarity are correlated with one another by visualizing the strength of the

relationship as a heatmap. The results provide an overview of the correlation in tie

strength across the members of the three participating organizations. The results indicate

that the variables are strongly correlated with each other. The weakest correlation exists

between awareness of difference in goals and the existence of common goals. A similar

pattern is observed between awareness of work practices and common work practices.

This suggests that the variables are correlated and thus that the strength of awareness of

difference, common ground, and knowledge sharing ties are likely to co-vary.
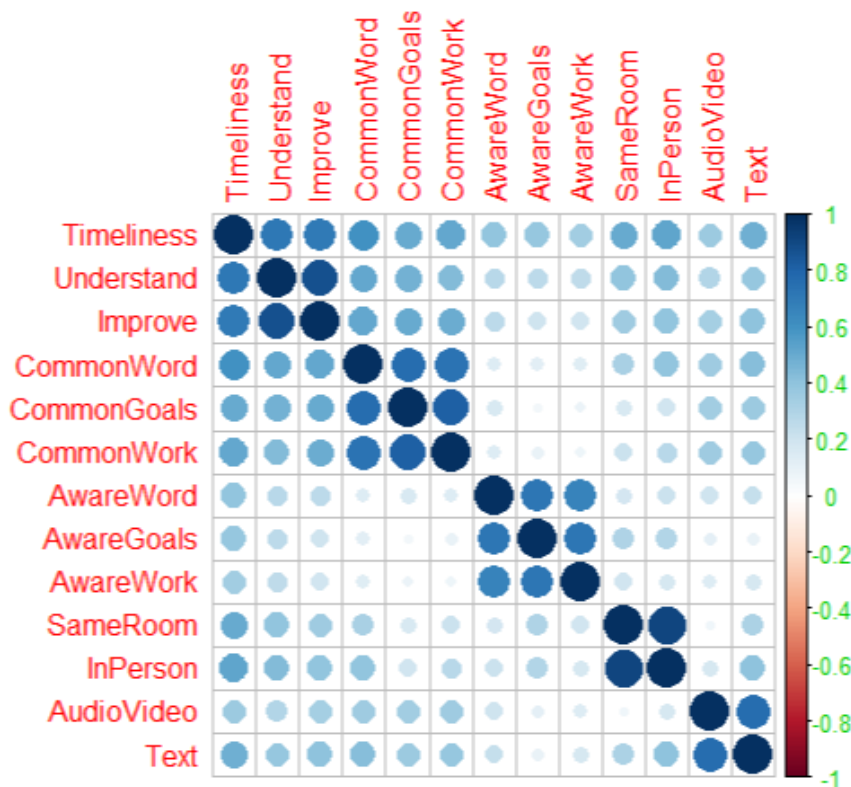
Figure 4. Correlation matrix visualized as a heatmap.

Table 8 provides the results of the multi-level regression model using the edge list dataset that aggregates findings across the three participating organizations. The model took the ego-alter and organization membership into consideration and is complementary to the QAP analysis by highlighting how the strength of ties co-vary across individuals and organizations. The results indicate the degree to which common ground, awareness and exposure ties where able to explain the variance in the knowledge sharing ties. The results show that aggregated measures of common ground, awareness, and exposure ties are statistically and positively associated with knowledge sharing ties.

Table 9

Multi-level Linear Regression Model Results on Aggregated Scores

	Estimate	Std Error	T Value	Pr(>|t|)	Sig. Level
(Intercept)	3.65	0.75	4.89	2.33e-06	***
F2Face	0.29	0.06	4.74	4.62e-06	***
F2Screen	0.20	0.08	2.48	0.014089	*
Aware Combined	0.18	0.05	3.45	0.000712	***
Common Combined	0.45	0.06	7.13	2.92e-11	***

Note. "***" indicates significant parameter at $p < .000$ and "*" indicates significant parameter at $p < 0.01$

Several iterations of the multilevel model were run. Due to the strong correlation between the variables, the individual measures canceled each other out in the analysis. A decrease in model terms helped combat overfitting of the model, as the aggregation of the variance based on a priori concepts revealed support for the hypotheses that knowledge sharing ties are likely to vary similarly with measures of common ground, awareness,

face-to-face exposure, face-to-screen. The addition of individual level measures to the

multilevel model, such as gender, was not found to impact the relationships between

network measures.

Hypotheses one is supported by the statistically significant and positive

relationship between knowledge sharing and the concepts of face-to-face exposure

($\beta_{F2Face} = 3.65$, p < .000) and text and audio/video-based exposure ($\beta_{F2Screen} = 0.29$, p <

0.01). Hypotheses 3, 4, and 5 are supported as variations in awareness of difference ties

followed those of knowledge sharing ties ($\beta_{AwareCombined} = 3.65$, p < .000). Lastly, the

findings show that hypotheses 6, 7, and 8 are supported by the statistically significant and

positive relationship between knowledge sharing and common ground measures

($\beta_{CommonCombined} = 3.65$, p < .000).

Tables 9, 11, and 13 provide an overview of the association between the networks

for Alpha, Bravo, and Charlie by providing the estimated coefficient of model terms and

their associated p-value from the QAP analysis. These results are complimentary to the

multilevel model as they both try to get at the strong ties that are associated with

knowledge sharing. Tables 10, 12, and 14 provide the R^2 value of the QAP models and

their associated p-value. Together the tables provide the estimated coefficient of the

model terms, the R^2 value, and the p-value. The estimated coefficient is the constant *B* of

the network regression equation that indicates the change in value of the dependent

network corresponding to the change in the independent network. The R^2 value provide

an estimate of the explanatory power of the model. For example, an R^2 value of 1.00

suggests that 100% of the variance between the independent and dependent networks are

being explained by the model. Lastly, the associated p-value is the probability that, when

the null hypothesis is true, the model results will be greater than or equal to the actual observed results (Field et al., 2012).

Hypothesis one proposed that multiplexity exists across the familiarity between organization members and the formation of knowledge sharing ties. QAP models were run to test the association between the network variables of knowledge sharing and familiarity. The concept of knowledge sharing was operationalized has containing three dimensions; knowledge sharing that improves the completion of tasks (KS_improve), is easily understood (KS_understand), and available in a timely manner (KS_time). Familiarity between organization members was operationalized as the frequency of which organization members found themselves in the same room (Fam_SameRoom), talking together (Fam_InPerson), and communicating via text (Fam_Text), audio and video technologies (Fam_AudioVideo). A QAP model was run for each of the possible combinations. The results from Alpha, Bravo, and Charlie company show that hypothesis one is supported. The results from the QAP models found a statistically significant and positive association between the variance in the dyadic ties of the knowledge sharing ties and the familiarity ties between organization members. For example, the QAP association between the KS_Improve and Fam_InPerson networks in company Alpha had an R^2 of 0.87 ($B = 0.96$, $p < .001$).

The network Fam_InPerson explained 87% of the variance in the KS_Improve network. A similar result was found between the networks of KS_Improve and Fam_InPerson in the Bravo ($R^2 = 1$, $B = 1$, $p < .001$) and Charlie ($R^2 = 1$, $B = 1$, $p < .001$). Across the three companies the knowledge sharing measures of KS_improve, KS_understand, and KS_time was statistically and positively associated with the

familiarity networks of Fam_InPerson, Fam_SameRoom, Fam_Text, and

Fam_AudioVideo. The lowest observed association between the networks were found in

company Charlie where the Fam_AudioVideo network explained 75% of the variance in

the KS_Improve network ($R^2 = .75$, $B = .95$, $p < .001$). Thus, hypothesis one is supported

as the results show that there is a statistically significant and positive association between

the familiarity ties of organization members and the formation of knowledge sharing ties.

Table 10

Matrix of the Association Between Networks Using QAP

Model Estimated Coefficients from Company Alpha

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 KS_Improve																
2 KS_Understand	1.00*															
3 KS_Timeliness	0.97*	0.97*														
4 Aware_Language	0.97*	0.97*	1.00*													
5 Aware_Interpretation	0.97*	0.97*	1.00*	1.00*												
6 Aware_Work	0.95*	0.95*	0.98*	0.98*	0.97*											
7 Common_Language	0.97*	0.97*	1.00*	1.00*	0.99*	0.97*										
8 Common_Interpretation	0.97*	0.97*	1.00*	1.00*	0.99*	0.97*	1.00*									
9 Common_Work	0.97*	0.97*	1.00*	1.00*	0.99*	0.97*	1.00*	1.00*								
10 Fam_InPerson	0.96*	0.96*	0.99*	0.99*	0.98*	0.96*	0.99*	0.99*	0.99*							
11 Fam_SameRoom	0.96*	0.96*	0.99*	0.99*	0.98*	0.96*	0.99*	0.99*	0.99*	1.00*						
12 Fam_Text	0.97*	097*	1.00*	1.00*	0.99*	0.97*	1.00*	1.00*	1.00*	0.94*	0.93*					
13 Fam_AudioVideo	0.97*	097*	1.00*	1.00*	0.99*	0.97*	1.00*	1.00*	1.00*	0.94*	0.93*	1.00*				
14 DiffBackground	0.95*	0.95*	0.98*	0.98*	0.97*	0.95*	0.98*	0.98*	0.98*	0.93*	0.91*	0.98*	0.98*			
15 DiffWork	0.95*	0.95*	0.98*	0.98*	0.97*	0.95*	0.98*	0.98*	0.98*	0.93*	0.91*	0.98*	0.98*	1.00*		
16 Distance	0.18	0.18	0.18	0.18	0.17	0.19	0.18	0.18	0.18	0.16	0.15	0.18	0.18	0.2	0.2	
17 Random_Generation	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.08	0.08	0.09	0.09	0.08	0.08	-0.08

Note: Table shows the estimated coefficient of the quadratic assignment procedure association between networks. "" indicates a p-value of .001 or lower.*

Table 11

Association Matrix of Networks Using the R-squared Value of QAP

R-squared Values from Company Alpha Models

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 KS_Improve																
2 KS_Understand	1.00*															
3 KS_Timeliness	0.93*	0.93*														
4 Aware_Language	0.93*	0.93*	1.00*													
5 Aware_Interpretation	0.92*	0.92*	0.93*	0.98*												
6 Aware_Work	0.88*	0.88*	0.95*	0.95*	0.93*											
7 Common_Language	0.93*	0.93*	1.00*	1.00*	0.98*	0.95*										
8 Common_Interpretation	0.93*	0.93*	1.00*	1.00*	0.98*	0.95*	1.00*									
9 Common_Work	0.93*	0.93*	1.00*	1.00*	0.98*	0.95*	1.00*	1.00*								
10 Fam_InPerson	0.87*	0.87*	0.93*	0.93*	0.91*	0.88*	0.93*	0.93*	0.93*							
11 Fam_SameRoom	0.85*	0.85*	0.91*	0.91*	0.91*	0.87*	0.91*	0.91*	0.91*	0.98*						
12 Fam_Text	0.93*	0.93*	1.00*	1.00*	0.98*	0.95*	1.00*	1.00*	1.00*	0.93*	0.91*					
13 Fam_AudioVideo	0.93*	0.93*	1.00*	1.00*	0.98*	0.95*	1.00*	1.00*	1.00*	0.93*	0.91*	1.00*				
14 DiffBackground	0.90*	0.90*	0.96*	0.96*	0.95*	0.92*	0.96*	0.96*	0.96*	0.90*	0.88*	0.96*	0.96*			
15 DiffWork	0.90*	0.90*	0.96*	0.96*	0.95*	0.92*	0.96*	0.96*	0.96*	0.90*	0.88*	0.96*	0.96*	1.00*		
16 Distance	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	
17 Random_Generation	0	0	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0	0	0.01	0.01	0	0	0.01

Note: Table shows the R-squared value of the quadratic assignment procedure association between networks. "*" indicates a p-value of .001 or lower.

Table 12

Matrix of the Association Between Networks Using QAP

Model Estimated Coefficients from Company Bravo															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1 KS_Improve															
2 KS_Understand	1.00*														
3 KS_Timeliness	1.00*	1.00*													
4 Aware_Language	1.00*	1.00*	1.00*												
5 Aware_Interpretation	1.00*	1.00*	1.00*	1.00*											
6 Aware_Work	1.00*	1.00*	1.00*	1.00*	1.00*										
7 Common_Language	0.96*	0.96*	0.96*	0.96*	0.96*	0.96*									
8 Common_Interpretation	0.96*	0.96*	0.96*	0.96*	0.96*	0.96*	1.00*								
9 Common_Work	0.96*	0.96*	0.96*	0.96*	0.96*	0.96*	1.00*	1.00*							
10 Fam_InPerson	1.00*	1.00*	1.00*	1.00*	1.00*	1.00*	0.97*	0.97*	0.97*						
11 Fam_SameRoom	1.00*	1.00*	1.00*	1.00*	1.00*	1.00*	0.97*	0.97*	0.97*	1.00*					
12 Fam_Text	1.00*	1.00*	1.00*	1.00*	1.00*	1.00*	0.97*	0.97*	0.97*	1.00*	1.00*				
13 Fam_AudioVideo	1.00*	1.00*	1.00*	1.00*	1.00*	1.00*	0.97*	0.97*	0.97*	1.00*	1.00*	1.00*			
14 DiffBackground	1.00*	1.00*	1.00*	1.00*	1.00*	1.00*	0.97*	0.97*	0.97*	1.00*	1.00*	1.00*	1.00*		
15 DiffWork	1.00*	1.00*	1.00*	1.00*	1.00*	1.00*	0.97*	0.97*	0.97*	1.00*	1.00*	1.00*	1.00*	1.00*	
16 Random_Generation	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03

Note: Table shows the estimated coefficient of the quadratic assignment procedure association between networks. "*" indicates a p-value of .001 or lower.

Table 13

Association Matrix of Networks Using the R-squared Value of QAP

R-squared Values from Company Bravo Models

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 KS_Improve																
2 KS_Understand	1.00*															
3 KS_Timeliness	1.00*	1.00*														
4 Aware_Language	1.00*	1.00*	1.00*													
5 Aware_Interpretation	1.00*	1.00*	1.00*	1.00*												
6 Aware_Work	1.00*	1.00*	1.00*	1.00*	1.00*											
7 Common_Language	0.95*	0.95*	0.93*	0.93*	0.93*	0.93*										
8 Common_Interpretation	0.95*	0.95*	0.93*	0.93*	0.93*	0.93*	1.00*									
9 Common_Work	0.95*	0.95*	0.93*	0.93*	0.93*	0.93*	1.00*	1.00*								
10 Fam_InPerson	1.00*	1.00*	1.00*	1.00*	1.00*	1.00*	0.93*	0.93*	0.93*							
11 Fam_SameRoom	1.00*	1.00*	1.00*	1.00*	1.00*	1.00*	0.93*	0.93*	0.93*	1.00*						
12 Fam_Text	1.00*	1.00*	1.00*	1.00*	1.00*	1.00*	0.93*	0.93*	0.93*	1.00*	1.00*					
13 Fam_AudioVideo	1.00*	1.00*	1.00*	1.00*	1.00*	1.00*	0.93*	0.93*	0.93*	1.00*	1.00*	1.00*				
14 DiffBackground	1.00*	1.00*	1.00*	1.00*	1.00*	1.00*	0.93*	0.93*	0.93*	1.00*	1.00*	1.00*	1.00*			
15 DiffWork	1.00*	1.00*	1.00*	1.00*	1.00*	1.00*	0.93*	0.93*	0.93*	1.00*	1.00*	1.00*	1.00*	1.00*		
16 Random_Generation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Note: Table shows the R-squared value of the quadratic assignment procedure association between networks. "*" indicates a p-value of .001 or lower.

Table 14

Matrix of the Association Between Networks Using QAP

Model Estimated Coefficients from Company Charlie

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1 KS_Improve															
2 KS_Understand	1.00*														
3 KS_Timeliness	1.00*	1.00*													
4 Aware_Language	0.95*	0.95*	0.95*												
5 Aware_Interpretation	0.95*	0.95*	0.95*	1.00*											
6 Aware_Work	0.95*	0.95*	0.95*	0.95*	1.00*										
7 Common_Language	0.97*	0.97*	0.97*	0.95*	0.95*	0.95*									
8 Common_Interpretation	0.97*	0.97*	0.97*	0.93*	0.95*	0.95*	1.00*								
9 Common_Work	0.96*	0.96*	0.96*	0.93*	0.93*	0.93*	0.99*	0.99*							
10 Fam_InPerson	1.00*	1.00*	1.00*	1.00*	0.93*	0.93*	0.99*	0.99*	0.96*						
11 Fam_SameRoom	1.00*	1.00*	1.00*	0.93*	0.93*	0.93*	0.99*	0.99*	0.96*	1.00*					
12 Fam_Text	0.95*	0.95*	0.95*	0.87*	0.87*	0.87*	0.94*	0.94*	0.91*	0.95*	0.95*				
13 Fam_AudioVideo	0.93*	0.93*	0.93*	0.85*	0.85*	0.85*	0.92*	0.92*	0.89*	0.93*	0.93*	0.98*			
14 DiffBackground	0.97*	0.97*	0.97*	0.95*	0.95*	0.95*	1.00*	1.00*	0.97*	0.97*	0.97*	0.83*	0.78*		
15 DiffWork	0.97*	0.97*	0.97*	0.95*	0.95*	0.95*	0.99*	1.00*	0.97*	0.97*	0.97*	0.83*	0.78*	1.00*	
16 Random_Generation	-0.1	-0.1	-0.1	-0.15	-0.15	-0.15	-0.13	-0.13	-0.1	-0.1	-0.1	-0.1	-0.08	-0.11	-0.13

Note: Table shows the estimated coefficient of the quadratic assignment procedure association between networks. "" indicates a p-value of .001 or lower.*

Table 15

Association Matrix of Networks Using the R-squared Value of QAP

R-squared Values from Company Charlie Models															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 KS_Improve																
2 KS_Understand	1.00*															
3 KS_Timeliness	1.00*	1.00*														
4 Aware_Language	0.88*	0.88*	0.88*													
5 Aware_Interpretation	0.88*	0.88*	0.88*	1.00*												
6 Aware_Work	0.88*	0.88*	0.88*	1.00*	1.00*											
7 Common_Language	0.96*	0.96*	0.96*	0.92*	0.92*	0.92*										
8 Common_Interpretation	0.96*	0.96*	0.96*	0.92*	0.92*	0.92*	1.00*									
9 Common_Work	0.92*	0.92*	0.92*	0.88*	0.88*	0.88*	0.96*	0.96*								
10 Fam_InPerson	1.00*	1.00*	1.00*	0.88*	0.88*	0.88*	0.96*	0.96*	0.92*							
11 Fam_SameRoom	1.00*	1.00*	1.00*	0.88*	0.88*	0.88*	0.96*	0.96*	0.92*	1.00*						
12 Fam_Text	0.81*	0.81*	0.81*	0.71*	0.71*	0.70*	0.78*	0.78*	0.74*	0.81*	0.81*					
13 Fam_AudioVideo	0.75*	0.75*	0.75*	0.64*	0.64*	0.64*	0.72*	0.72*	0.68*	0.75*	0.75*	0.91*				
14 DiffBackground	0.96*	0.96*	0.96*	0.92*	0.92*	0.92*	1.00*	1.00*	0.96*	0.96*	0.96*	0.78*	0.72*			
15 DiffWork	0.96*	0.96*	0.96*	0.92*	0.92*	0.92*	1.00*	1.00*	0.96*	0.96*	0.96*	0.78*	0.72*	1.00*		
16 Random_Generation	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	

Note: Table shows the R-squared value of the quadratic assignment procedure association between networks. "*" indicates a p-value of .001 or lower.

Hypothesis two proposed that knowledge sharing ties were likely to be reciprocated. An ERGM was created for each of the three participating organizations. Tables 14, 15, and 16 provide an overview of the ERGMs. The models included control variables that took into consideration if similarity of gender and hierarchy (*nodematch* parameter) had an impact on the formation of knowledge sharing ties. Additionally, the company and industry tenure of the employees were taken into consideration using the *nodeocov* parameter. A test to identify the goodness of fit was run for each of the presented models. The *idegree, odegree, edgewise shared partners,* and *geodesic distances* parameters were used to test the goodness of fit. Figures 5 and 6 show results for the *idegree* and *odegree* parameters on the attribute focused ERGMs using the aggregated data. The ERGM simulations followed the overall tendencies of the observed network, but do not fit as expected in an ideal case. This overall model demonstrates an acceptable level of fit for analysis, although it is possible that better fitting models could be obtained.
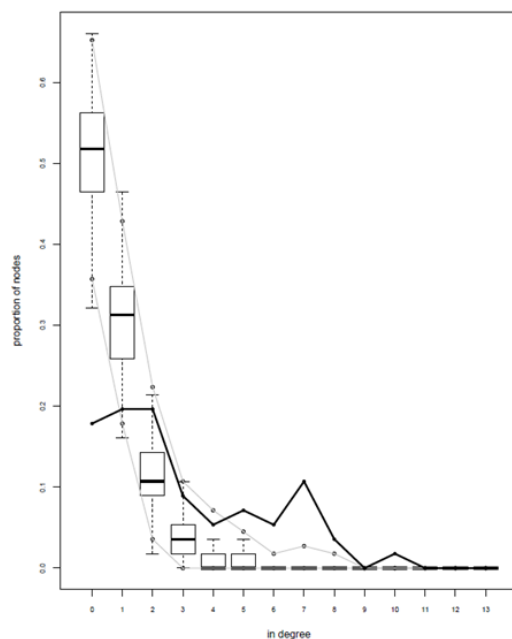
Figure 5. Boxplot of In-degree from the Aggregated Model Across Organizations.
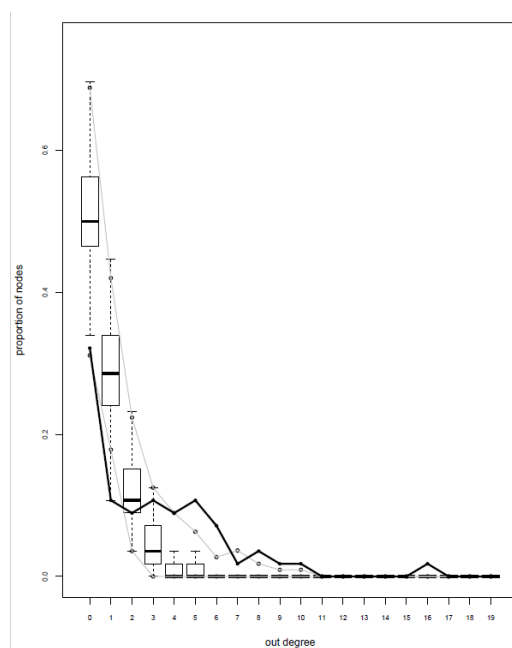

Figure 6. Boxplot of Out-degree from the Aggregated Model Across Organizations.

Table 16

ERGM of Aggregated Knowledge Network Across Organizations

Parameter	Estimate	Standard Error	P-value
edge	-4.273914	0.199858	<1e-04 ***
mutual	1.087412	0.514979	0.0347 *
gwesp	1.825129	0.170748	<1e-04 ***
nodematch(Gender)	-0.106811	0.248979	0.6679
nodematch(Hierarchy)	-0.237433	0.253089	0.3482
nodeocov(Company Tenure)	0.005217	0.025917	0.8405
nodeocov(Industry Tenure)	-0.018554	0.015161	0.221

*Note. "***" indicates significant parameter at p < .000, and "*" indicates significant parameter at p < 0.01*

Table 17

ERGM of Aggregated Knowledge Network at Alpha

Parameter	Estimate	Standard Error	P-value
edge	-2.740194	0.25635	<1e-04**
mutual	0.6158597	0.4801931	0.1997
gwesp	1.098255	0.2139253	<1e-04**
nodematch(Gender)	-0.205866	0.3955672	0.6028
nodematch(Hierarchy)	-0.684401	0.4092923	0.0945
nodeocov(Company Tenure)	0.0006975	0.0339484	0.9836
nodeocov(Industry Tenure)	-0.059054	0.0233382	0.0114 *

*Note. "**" indicates significant parameter at p < .001, "*" indicates significant parameter at p < 0.01 "" indicates significant parameter at p <0.05*

Table 18

ERGM of Aggregated Knowledge Network at Bravo

Parameter	Estimate	Standard Error	P-value
edge	-4.76975	0.691601	<1e-04**
mutual	0.318098	0.540782	0.556
gwesp	1.24883	0.222704	<1e-04**
nodematch(Gender)	-0.68688	0.439325	0.118
nodematch(Hierarchy)	0.105966	0.37119	0.775
nodeocov(Company Tenure)	0.003521	0.027678	0.899
nodeocov(Industry Tenure)	0.010018	0.016041	0.532

Note. "**" indicates significant parameter at p < .001

Table 19

ERGM of Aggregated Knowledge Network at Charlie

Parameter	Estimate	Standard Error	P-value
edge	-4.7697	0.691601	<1e-04*
mutual	0.31809	0.540782	0.556
gwesp	1.2488	0.222704	<1e-04*
nodematch(Gender)	-0.6868	0.439325	0.118
nodematch(Hierarchy)	0.10596	0.37119	0.775
nodeocov(Company Tenure)	0.00352	0.027678	0.899
nodeocov(Industry Tenure)	0.01001	0.016041	0.532

Note. "*" indicates significant parameter at p < .001.

The model based on data from Alpha suggests that reciprocity does not exist in the observed knowledge sharing network (*mutual* parameter with $B = 0.61$, $p > 0.05$) and that the formation of knowledge sharing ties are selective (edge parameter with $B = -2.74$,

$p < 0.001$). Additionally, the control variable of industry tenure was found to be statistically significant and negatively associated with the formation of knowledge sharing ties (*nodeocov* parameter with $B = -0.05$, $p < 0.05$). Lastly, the gwesp parameter ($B = 1.09$, $p < 0.001$) was statistically significant and positively associated with the formation of knowledge sharing ties. This suggests that employees in Alpha develop clusters in their knowledge sharing networks. Overall, the model shows that employees at Alpha are selective in the formation of knowledge sharing ties, likely to cluster, and that tenure at the company decreases the formation of knowledge sharing ties.

Table 15 shows the results of the ERGM run on data from Bravo. The results do not support hypothesis two as the *mutual* parameter ($B = 0.31$, $p < 0.05$) was non-significantly associated with the formation of knowledge sharing ties. The *gwesp* parameter ($B = 0.31$, $p < 0.001$) was statistically significant and positively associated with the formation of knowledge sharing ties and suggest that clusters exist in the knowledge sharing network. Similarly, to the results from Alpha, the formation of knowledge sharing ties were spare ($B = -4.76$, $p > 0.001$). Overall, the model suggests that the employees at Bravo are unlikely to form knowledge sharing ties and that knowledge sharing ties often exist within clusters.

Table 16 shows the results of the ERGM run on data from Charlie. The results do not support hypothesis two as the *mutual* parameter ($B = 031$, $p < 0.05$) was non-significantly associated with the formation of knowledge sharing ties. Like the results from Alpha and Charlie company, employees at Bravo were likely to cluster together when forming knowledge sharing ties (*gwesp* parameter with $B = 1.24$, $p < 0.001$). Combined the results of the ERGMs for Alpha, Bravo, and Charlie do not support

hypothesis two and thus the hypothesis is rejected. The results point to the formation of knowledge sharing ties being selective and often existing with clusters in the networks.

Hypothesis three posits that multiplexity exists between knowledge sharing ties and organization members awareness of differences in language use. QAP results from company Alpha showed a statistically significant and positive association between the KS_Improve and Aware_Language ($R^2 = 0.93$, $B = 0.97$, $p < .001$). Similar results were found for Bravo ($R^2 = 1.00$, $B = 1.00$, $p < .001$) and Charlie ($R^2 = 0.88$, $B = 0.95$, $p < .001$). The knowledge sharing networks KS_understand and KS_Timeliness had a similar association between awareness of difference in language use with the lowest association existing in company Charlie. KS_understand was associated with Aware_Language ($R^2 = 0.88$, $B = 0.95$, $p < .001$)   and KS_Timeliness was associated with Aware_Language ($R^2 = 0.88$, $B = 0.95$, $p < .001$). Combined the results suggest that being aware of other organization members' language use ease the formation of knowledge sharing ties. Hypothesis three is therefore supported by the results.

Hypothesis four states that knowledge sharing ties are likely to be formed between organization members that are aware of difference in interpretation. QAP results from Alpha, Bravo, and Charlie support the notion. Data from Alpha showed a statistically significant and positive association between the KS_Improve and Aware_Interpretation networks ($R^2 = 0.97$, $B = 0.92$, $p < .001$). Similar results were found for Bravo ($R^2 = 1.00$, $B = 1.00$, $p < .001$) and Charlie ($R^2 = 0.92$, $B = 0.95$, $p < .001$). The lowest association between the knowledge sharing networks and awareness of difference in interpretation was found in Charlie. The KS_timeliness network explained 88% percent of the variance in the Aware_Interpretation network at Charlie ($R^2 = 0.88$, B

$= 0.95$, $p < .001$). Combined the results highlight that awareness of interpretation is associated with the formation of knowledge sharing ties. Thus, hypothesis four is supported.

Hypothesis five propose that knowledge sharing ties form between organization members that are aware of difference in work practices. Results from the QAP analyses found a statistically significant and positive association between knowledge sharing networks and awareness of difference in work practice. The association between Alpha's KS_Improve and Aware_Work networks was statistically significant and positive Alpha ($R^2 = 0.88$, $B = 0.95$, $p < .001$). The results were mirrored in Charlie company ($R^2 = 0.88$, $B = 0.95$, $p < .001$) and Bravo ($R^2 = 1.00$, $B = 1.00$, $p < .001$) between the KS_Improve and Aware_Work networks. A statistically significant and positive association was found between all the knowledge sharing networks and the awareness of difference in work practice network. Thus, hypothesis five is supported.

Hypothesis six suggest that knowledge sharing ties are likely to form between organization members that share common language use. The results support the hypothesis. For example, the association between KS_Improve and Common_Language networks was statistically significant and positive in Alpha ($R^2 = 0.93$, $B = 0.97$, $p < .001$), Bravo ($R^2 = 1.00$, $B = 1.00$, $p < .001$), and Charlie ($R^2 = 0.96$, $B = 0.97$, $p < .001$). The degree of common ground in language between organization members was statistically significant and positively associated with formation of knowledge sharing ties. Hypothesis six was supported.

Hypothesis seven posits that knowledge sharing ties are likely to exist between organization members that have common ground in interpretation. The hypothesis was

supported by the QAP results. A statistically significant and positive association was found between Common_Interperation and KS_Improve, KS_Understand, and KS_Timeliness. For example, in company Alpha the Common_Interpretation network explained 93% of the variance in the KS_Timeliness network ($R^2 = 0.93$, $B = 0.97$, $p <$ .001). Thus, hypothesis seven is supported by the results.

Hypothesis eight state multiplexity exists between knowledge sharing ties and common ground in work practice ties. The results corroborate the hypothesis as a statistically significant and positive association was found between the Common_Work network and KS_Improve, KS_Understand, and KS_Timeliness networks. The lowest association between the networks was found between KS_Improve and Common_Work in Charlie company ($R^2 = 0.92$, $B = 0.96$, $p < .001$). Hypotheses eight is supported by the data.

Table 17 provides an overview of the tested hypotheses. All hypotheses, with the exception of hypothesis two, was supported by the quantitative findings. The results found that the degree of awareness of difference and common ground between two organization members in regard to language use, interpretation, and work practice were likely to co-vary with the formation of higher quality knowledge sharing ties. These results were supported across Alpha, Bravo, and Charlie.

Table 20

Overview of Supported Hypotheses

Proposition	Analytic Results
H1: The higher a frequency of communication is between two organization members, the more likely they are to have increased knowledge sharing.	Supported
H2: Organization members are more likely to engage in knowledge sharing with organization members who reciprocate in sharing knowledge	Unsupported
H3: The higher awareness of differences in language use between two organization members, the more likely they are to have increased knowledge sharing.	Supported
H4: The higher awareness of differences in interpretation between two organization members, the more likely they are to have increased knowledge sharing.	Supported
H5: The higher awareness of differences in work practices between two organization members, the more likely they are to have increased knowledge sharing.	Supported
H6: The higher degree of common language use between two organization members, the more likely they are to have increased knowledge sharing.	Supported
H7: The higher degree of common interpretation between two organization members, the more likely they are to have increased knowledge sharing.	Supported
H8: The higher degree of common work practices between two organization members, the more likely they are to have increased knowledge sharing.	Supported

Chapter 5: Exploring Knowledge Sharing Facilitation

"Complex problems in science, business, and engineering typically require some tradeoff between exploitation of known solutions and exploration for novel ones, where, in many cases, information about known solutions can also disseminate among individual problem solvers through formal or informal networks." – Mason and Watts (2012, p. 764)

The following chapter examines the qualitative results and homes in on examining how relational ties impact knowledge sharing between organization members. The qualitative analysis provides in-depth accounts of how awareness of difference and common ground impact knowledge sharing. Specifically, the awareness and common ground surrounding language use, interpretation, and work practices in the three participating organizations is explored, as is the type of conversations between organization members that facilitates knowledge sharing.

The qualitative content analysis consisted of a two-step iterative process of interviewing that was repeated until saturation was reached. Saturation was reached when no new mutually exclusive themes emerged in the examination of the interview data (Lofland et al., 2006). The first step in the analysis was to identify potential themes related to the formation of ties between organization members that facilitated knowledge sharing. The second step in the analysis process was to compare, contrast, and ultimately combine themes that were conceptually similar. The a priori concepts of language, interpretation, and work practice was uses as the basis for identifying and merging themes. The two steps were repeated in an interactive process where the identified themes were contracted and expanded. The analysis reveals six major categories describing how awareness of difference and common ground in language, interpretation, and work practice are formed between organization members. A total of 26 associated themes were identified as belonging to the 6 major categories.

Awareness of Difference

Table 18 summarizes the three major categories belonging to awareness of difference and contains examples for each of the 12 associated themes. The major categories under awareness of difference was language use, interpretation, and work practice. Three themes were identified regarding language use, five themes were found for interpretation, and four themes surrounding work practice were discovered. Focus was given to the strategies and situation were organization members engaged with others that helped them develop an awareness of difference.

The first major category was awareness of difference in language use. Language use refer to the difference in terminology, words, analogies, and concepts that organization members use in their everyday practice to describe situation and problems. A total of three themes were associated the category of language use in regard to awareness of difference. The following sections explicate the themes of clarification of difference, difference as boundary, and social cues as context.

Clarification of difference. The theme of clarification of difference was described by participants as the moments when they noticed others using unknown terminology that lead them to probe about their language use. The organization members described several techniques that helped them to understand differences in language use. For example, using documents as a reference points, asking for others to repeat their ideas in a different way, or simply asking for clarification of specific terminology. An engineer at Bravo described how examining physical objects helped him develop an awareness of differences in language use:

So there's just like language and stuff like that that people use in industrial design that I don't really understand, where they're talking about how from one angle this thing looks bad (...) I have no idea what they're talking about. But then if they take a step back and show me and they show me like a product that's out there like oh, look at this electric razor. Like if you look at it from here, it's just a clunky thing. But then if you look at it from the way a person would hold it, it's pretty slim and pleasing to the eye. I'm like okay, that's interesting.

The engineer points out how a physical object was used to understand the design process and rationale behind design choices. By using physical objects, a group of designers were able to convey the meaning of their discussion to another person. The goal of the interaction was not to create a shared language use but to create an awareness of the concepts that they were discussing. Clarifying differences is important for organization members as it helps them understand the expertise of others and how the expertise can help them achieve their goals.

The theme of clarification of difference represent instances where organization members use strategies to understand the underlaying meaning of a word or conversation without the aim to create a common language. However, clarification of difference does not only happen in interactions with others. The participants often describe how they would seek out an understanding of a word on their own if they needed to understand it. A content creator at Alpha described the self-seeking strategy as following: "*I write meeting minutes, but if I don't know something, if it's technical, I'll just write it down and try and look it up myself. And if I just can't figure it out, then I'll ask.*" Directly asking for clarification was often the last option described by the interviewed organization members, as they tried to be aware of what others were saying without interrupting or repeatedly asking for clarification.

Difference as boundary. The second identified theme associated with awareness of difference in language use was difference as boundary. Difference as boundary was described by participants as interactions where they withheld the exploration of unfamiliar language. Oftentimes the organization members did not see a need to understand specific language use unless it was directly related to their work. A content creator at Bravo summarized it in the follow way: "*Sometimes when they get to the technical aspects in a particular project (...) it just goes right over my head (...) but it's not really something that I have a need to know anyway.*" The interviewed organization members described how the time and energy needed to explore difference in language use often acted as a deterrent for exploration. The interviewee did not see a need to fully understand the language use of others, as other organization members were responsible for the execute of tasks outside the resort the interviewee. Several strategies were used to withhold exploration of difference in language, such as sitting back and listening, faking understanding, or already feeling an adequate understanding of the language used. Organization members' expertise acts as a boundary where others do not feel the need to develop an understanding. In doing so, difference as a boundary help establish who executes on what tasks between organization members and draws a line for who is seen as an expert.

Social cues as context. The third theme identified in association with awareness of difference in language use was social cues as context. Social cues are the verbal and non-verbal signals send by organization members as they engage in interactions with others, such as a raised voice or animated arm movements. Participant highlighted how identifying verbal and non-verbal cues help develop an understanding of what others are

saying. Social cues provide a contextual awareness of what is important and guide organization members in what situation and issues that they are needed to contribute towards. A project manager at Bravo describe how he uses verbal and non-verbal cues during meetings to gauge the importance of conversations: "*So if they say, yeah, it's fine, we can move forward with it, I'll be, like, well, they said it's fine. That's not good. So how do we make it good whereas it'd, like, oh, it's fine, so let's move on to the next part.*" Here an organizational member questions the degree to which a client is satisfied by reflection on the use of language use. Specifically, the use of the word 'fine' makes the project manager probe into the satisfaction of the client. Noticing the verbal and non-verbal cues help establish if a conversation or concept is important to understand and explore. Social cues provide context that help organization members understand where others are coming from and the importance of what they are saying.

Awareness of difference and interpretation. Awareness of difference in interpretation was the second major category. Interpretation is the way in which organization members understand and think about information and problems. The content coding revealed five associated themes that fell under the major category of interpretation in regard to awareness of difference. The identified themes include developing awareness, exploring difference, conveying difference, accepting difference, and tackling difference between organization members. Participants described how several strategies were used to develop an awareness of difference in interpretation. The following section describe each of the identified themes and how these can help facilitate knowledge sharing.

Developing awareness. The theme surrounding the development of awareness shows how organization members tried to passively glean an understanding of how others would interpret information and build friendships that could serve as the foundation for understand a difference in interpretation. Developing awareness of difference is the conscious and unconscious discovery of difference between organization members. An industrial designer at Bravo described how proximity helped develop an awareness of difference in interpretation:

> *She started to push for us to all be in the same room because she felt the disconnect being outside. And she felt -- she was a real proponent of putting us all in the same room. That way we always knew what was going on with each other's projects and it was really easy to just talk back and forth, get a quick opinion.*

As this quote demonstrates, developing an awareness of difference in interpretation is not excluded to the conscious engagement between organization members. The industrial designer describes how the physical place within the same office space helped keep him up to date on others progress. Developing awareness is a continuous and ongoing process of gauging how others see and understand problems. However, trying to develop an awareness of difference in interpretation can be a challenge for organization members as they do not know where to start. A participant described the challenge as*, "There is so much information to learn that like I'm, like to explain like a quarter of it and try to get them to like understand the whole thing is impossible.*" Here an interviewee from Alpha describes the frustration felt when trying to share all the needed information to understand a problem. The observations conducted at Alpha revealed how a gap existed between content creators and software developers. The content creators did not fully understand what was possible and the timeframe needed to

accomplish various software development tasks. Developing awareness takes times. Organization members talked about the need to be exposed to technical challenges and directly work with developers to be able better understand where they are coming from. Developing an awareness of difference in interpretation is therefore not easily done in a short time span as it requires a deliberate effort, time, and energy.

Table 21

Awareness of Difference: Major Categories and associated concepts

Major Categories	Associated Themes	Description	Examples
Language	Clarification of Differences	Strategies used to clarify language used	"He knows the intricacies of all these I.V. tubes that he's ordering and I don't know anything about them. So I'm like: You're going to need to tell me specifically what I need to change about this purchase order."
	Differences as Boundary	Withholding the exploration of unfamiliar language	"Sometimes it's also just sitting back even if you don't know a term that they're using, if they're using it wrong, just sit back and then just listen."
	Social Cues as Context	Using verbal and non-verbal cues to adapt language use	"I mean, just getting to know people and their mannerisms I just kind of -- when they are coming out strong, when they're coming on helpful, when they are coming on, like -- you can tell a difference -- so you just take it all that in. Before I open my big mouth, which, sometimes we all do too soon -- you know?"

Table 21 continued

Awareness of Difference: Major Categories and associated concepts (cont.)

Major Categories	Associated Themes	Description	Examples
Interpretation	Developing Awareness	Situations and strategies that provide an understanding of others' interpretations	"She was a real proponent of putting us all in the same room. That way we always knew what was going on with each other's projects and it was really easy to just talk back and forth, get a quick opinion."
	Exploring Differences	Seeking out different perspectives and interpretations	"I learned quickly that instead of pointing out flaws I should have been asking them reasons why. And to understand their thought process leading into their choices (...) learning myself that their choices are better than what I would have chosen."
	Conveying Differences	Expressing your own interpretation and perspectives so others understand you	"I want Jamie to know where I'm coming from and I want to know where he's coming from. And because of that we can both agree -- we can both see each other's side of it and maintain like respect throughout it."
	Accepting Differences	Withholding engagement with others' perspective due to differences in interpretation	"Some people are [technical] and some people aren't (...) Susan said, "The way you're setting it up, people can't take advantage of all the features." I said, "That's okay, because half the people in our company wouldn't know how to take advantage of those features and I'm dumbing it down.""
	Tackling Differences	Strategies used to navigate differences in interpretation	"In the meeting, we went back and forth various times, and at a certain point, I would just say, okay. Even though it doesn't make sense, and I'm not going to implement what he is saying because it will not benefit the company."

Table 21 continued

Awareness of Difference: Major Categories and associated concepts (cont.)

Major Categories	Associated Themes	Description	Examples
Work Practice	Developing Awareness	Situations and strategies that provide an understanding of others' work practices	"When it comes to technology, I go to Susan because when I first started out, she helped me set up my computer, so I went, I associate her with technology."
	Accepting Differences	Withholding engagement with others' perspective due to differences in work practices	"I think it's just better to just say "hey, honestly this is my first time doing this" and like I'm, you know, you just set the expectation that like -- like you're forced to know something, and you don't know."
	Tackling Differences	Strategies used to navigate differences in work practice	"She's like, well, like, I just think this looks like shit, blah, blah, blah, you know, that's just like kind of her personality. So it's just like I feel like the way that people will interact with you is that, that's how I figured out who to go to."
	Enablement	Possibilities provided by knowing others' work practices	"From the beginning, Lizzy said, "I got this," and I said, "Good. I don't want to know about it. I just want you to tell me when it's fixed and what I have to do" (…) I won't understand what they're doing but I'll purposely kind of stay out of it."

Exploring difference. The second identified theme in regard to awareness of difference in interpretation was exploring difference. Exploring difference are the moments and situation were organization members deliberately reach out to gather other's perspectives and interpretations. The exploration of difference between organization members is a deliberate strategy employed that often builds on the realization of a lack of understanding. One participant describes how she changes behavior to better understand others' interpretations:

> *I would point out flaws in what they were doing and then I learned quickly that instead of pointing out flaws I should have been asking them reasons why. And to understand their thought process leading into their choices and then potentially leading them into realizing that their choice may not have been the best choice. Or learning myself that their choices is better than what I would have chosen.*

Here the organizational member actively points out a lack of expertise, as to ensure that differences are explored, and an expectation of exploration is established. Exploring difference can help organization members realize why others are taking a certain approach to their work and help eliminate misunderstandings. Generally, the interview data suggests that participants saw it as important to understand what others know, probing about why they hold certain interpretations, and rely on people with a healthy distance to their projects to provide feedback.

Conveying Difference. The third theme identified was the strategies used by organization members to express their own interpretations, so others could understand them. Conveying difference is the active engagement by organization members to describe how they understand and think about problems and information. The participants saw it as important to explain where they were coming from, explaining their choices,

and understanding difference in goals. An engineer at Bravo describes the importance of

understanding the goal of others to better convey his interpretation of the situation:

> *Just getting an understanding of, okay, what are they trying to achieve out of this. Because if I just said make this look nice, these are the things that need to be a part of it, then they'll go sketch things and then I'll have to say, well, they can't do that and they'll say why not?*

The participant describes the importance of conveying where he was coming from and

the requirements of mechanical parts that needs to be included in the final product. To

successfully convey differences organization members must have a foundational

awareness of where they differ. In this regard the theme of conveying difference is

closely tied to the development and exploration of differences, as participants described

an interaction effect and feedback mechanisms. The more organization members develop

and explore difference, the easier it is to convey their own differences to others in a

respectful manner.

> **Accepting Difference.** The fourth theme was accepting difference. When

exploring and conveying difference in interpretation, the participants described how they

came to an acceptance in difference. Accepting difference is a type of strategy used by

the organization members to set boundaries around what interpretations to engage and

how to deal with disagreements. Participants described how they take a step back,

ignoring non-important interpretations, and selectively incorporate interpretations into

their work. The participants would withhold engagement with others' interpretations. A

brokerage trader at Charlie describes accepting difference as following:

> *It's stepping back and asking questions or even if you know their way isn't gonna get there, let them continue through their way, and then see that that's not working. Sometimes it's hard for me because it's kind of wasting time. But it's trial and error where people have to make their own mistake. Learning on their own. You have to get — the person has to get there on their own. And you telling*

them isn't gonna — even if you're right, doesn't mean it's gonna change their
behavior at that time.

Here the brokerage trader points to the importance of letting others form their own

opinion and experiences, as the active engagement and correction of interpretation can be

seen as hostile. To accept difference in interpretation, the participants described how they

tried to take their own limitations into consideration while respecting that interpretations

would differ. Organization members need to respect the interpretations of others and limit

their tendencies to disagree with others until necessary. Participants described how letting

others learn on their own could delay projects but was beneficial in the long run as it

would give others time to build their expertise through experience.

Tackling Difference. The fifth theme moved beyond accepting difference and

probed into how organization members tackle difference in interpretation. Several

methods were used to tackle differences in interpretations. Participant talked about how

they would change approach, be selective in which fights to take, evoke client goals,

provide multiple options, break an issue into subparts, or summarizing conclusions. A

participant describes her approach to handling difference in interpretation:

> *We all have different approaches to stuff (…) certain people may think that they*
> *know the right way to do something but at the end of the day, it's your client. (…)*
> *You probably should be the authority on it. Have you ever heard the term, too*
> *many chefs? That can easily apply to some stuff when -- sometimes we all feel the*
> *need to jump in and kind of throw our two cents but -- you know, that can be*
> *helpful sometimes -- you should also be like, hey, listen. I don't know what's*
> *working on this. Does anybody have any ideas?*

Tackling difference in interpretation is a challenge for organization members as they both

have to hold their ground while remaining open to others' perspectives. One strategy

described by several participants was to ensure that others were aware of the same

documents and information as to help align their interpretations. Tackling difference

therefore has to be seen as a balance act between conforming and putting one's foot down.

Awareness of Difference and Work Practice. The third major category was awareness of difference in work practice. Four themes were associated with the category. The category contained four themes. The themes included developing awareness, accepting differences, tackling difference, and enablement due to awareness of work practices. Awareness of difference in work practice is organization members understanding of how others approach problems and the deadline that they face.

Developing Awareness. First, the theme developing awareness was identified. The theme aimed to capture the situations and strategies that provide organization members with an understanding of others work practices. Central to the theme was the exposure of prior work and collaborations between organization members, tracing their experience through previously created documents, and breaking down their area of expertise. One participant noted that he learned about others work practices and expertise through exposure:

> *I always knew kind of like what an industrial designer was and I always just thought of them as like people who were good at drawing and coming up with crazy forward thinking, futuristic ideas. And -- but not necessarily doing the technical side of how things work. But coming here to this group it seems like they're a lot more in tune with that technical side and so they're aware of it and think about it in advance so that we don't get stuck in like really big snags.*

Being aware of difference in work practices allow organization members to account for their approaches to tasks and helps facilitate the timely completion of tasks. Being aware of difference in work practice help organization members collaborate and ease knowledge sharing. Understanding others work practices was described as providing the foundation for developing common ground between organization members. Being aware

of difference in work practice allows organization members to understand where other

are coming from and the responsibilities that they hold.

Accepting Difference. The second theme associated with awareness of difference

in work practices was accepting difference. Accepting differences in work practices is the

disclosure of limitations, taking difference into account, doing things your own way, and

understanding others approach to tasks. Similarly to accepting difference in regard to

interpretation, organization members described how giving room for others to approach

problems on their own terms helped facilitate a positive relationship and ease knowledge

sharing. A content creator at Alpha remarked that: "*It's just better to just say hey,*

honestly this is my first time doing this (...) you just set the expectation (...) I think that's

the problem people have is like you come in and (...) you're forced to, like that you know

something and you don't know." Here the organizational member points out the

importance of letting go of preference and establishing a limited understanding of the

work processes of others. In doing so expectation are set with other organization

members that they should not expect others to be experts outside their areas. Accepting

difference in work practices require organization members to be both beware of their own

and others expertise. By accepting difference organization members are able to negotiate

their own contributions to tasks and to draw on others when needed.

Tackling Difference. The third theme was tackling differences. Tackling

differences in work practices are the strategies used by organization members to navigate

difference in work practices. The participants described how differences in work practice

could lead to alienation and a feeling of being overwhelmed. A project manager at Alpha

describes the challenges associated with difference in work practices: "*He likes to send*

me the code to look through. I'm getting better at it. But looking at code, I'm not a

programmer, I'm not a developer, I'm not." Here the interviewee points out her own lack

of expertise and goes on to describe how she communicates the lack of expertise.

However, through continuous engagement with the same developer the project manager

was able to slowly build a better understanding of the challenges and limitations that

faced the developer. The strategy of the participant was to accept the work practice while

slowly gaining experience in reading code. Tackling difference in work practice provides

a dilemma for organization members because they have to remain respectful, learning as

the collaborations evolves, while also trying to deepen their understanding of the

differences**.** Tackling difference in work practice therefore erects boundaries to

knowledge sharing that are able to be broken down through continuous exposure between

organization members.

      Enablement. The fourth theme was enablement. Being aware of differences in

work practices allows organization members to forward tasks to those best suited to

complete them, understanding their availability and deadlines, while keeping an eye on

potential obstacles that can arise in the future. In this regard, being aware of difference in

work practice also helps organizations to redirect information, gauge the level of details

needed to complete tasks, and pushing back on proposed deadlines. One participant

described how awareness of difference in work practices allows him to remove himself

from tasks:

      "*From the beginning, Jimmy said, "I got this," and I said, "Good. I don't want to*

      know about it. I just want you to tell me when it's fixed and what I have to do."

      (…) I won't understand what they're doing but I'll purposely kind of stay out of it."

Being aware of difference in work practice allows organization members to redirect

information and tasks to those best suited to handle them. Awareness of others work

practices enable organization members to focus on the tasks that they feel competent in

completing and that they enjoy. By doing so organization members feel more confident in

engaging with experts in other areas, as they know and can anticipate the way they

approach problems. Being aware of work practices can ease the allocation of tasks to

those most suited to solve them and thus ease knowledge sharing by providing

opportunities for exposure. Being aware of difference in work practice provide a

foundation upon which organization members can build common ground.

Common Ground

Table 19 provides an overview of the major categories and themes identified

regarding the existence of common ground between organization members. The content

analysis focused on identifying the situations and interactions that formed common

ground between organization members. Three themes were identified regarding language

use, five themes were revealed for interpretation, and six themes surrounding work

practice was explored. The findings suggest that awareness of difference in language use,

interpretation, and work practice are the foundation for the development of common

ground between organization members.

Common Ground and Language Use. The first major category was awareness

of difference in language use. Three themes were associated with the category. The

themes included cementation, mediation, and co-creation of language use between

organization members. Common ground in language use is the way organization

members use similar terminology, words, and analogies to describe problems, situations,

and information. The strategies described by the interviewed organization members focus

on the relational aspects that helps facilitate knowledge sharing by creating common

ground.

Table 22

Common Ground: Major Categories and associated concepts

Major Categories	Associated Themes	Description	Examples
Language	Cementation	Strategies used to develop similar language use	"So I'm telling them – I'm asking them, I'm describing it to them; What do you call this again?"
	Mediation	Using the same language depending on who is engaged	"They [developers] don't get anything directly from anybody else. So I know if they're [employees] coming to me and they say they want the [nickname 1] changed, they want the [nickname 2] changed, I just let them [developers] know [original name]."
	Co-creation	Creating terminology and language use with others	"We had lots of jokes about it in the meeting for a long time, like is it the 2 or the 1, the 2, or is the 1 before the 2, I don't know and then all of our projects have little nicknames that usually start from the project code and then we just start calling it that."

Table 22 continued

Common Ground: Major Categories and associated concepts (cont.)

Major Categories	Associated Themes	Description	Examples
Interpretation	Developing Common Ground	Requirements for the development of a common interpretation	"Prior to the kickoff meeting with the client we'll have an internal kickoff where they kind of download what they've learned about this project so far. So that we have a general base understanding and they'll tell us where all the documents that the clients have provided us with for us to read through."
	Shared Frame of Reference	Objects, documents, and strategies used to guide common interpretation	"I have that documentation (...) so you kind of have that guidance and you can always look back and if they're like why did you do that? And then you're like well, back in August we determined that it's easier to do this."
	Proactive Engagement	Strategies used to ensure common interpretation before issues arise	"They are introducing a new project with John. And we'll meet after and I'll be like (…) did you understand it? (…) and she will be like, no, no, no, I thought it was this, and then we'll figure it out together."
	Co-creation	Joint creation of objects and documents to ensure common ground	"Her and I went back and forth for a while putting something together that was what she was expecting. I'm working with her to get what her expectations were down on paper."
	Enablement	Possibilities provided by sharing similar interpretations	"It has a really tight deadline. "Susan, we can't hit that deadline." "Jimmy, we don't have to have it all done by that date. We'll just get a piece of it done (...) Just focus on getting a piece it done."

Table 22 continued

Common Ground: Major Categories and associated concepts (cont.)

Major Categories	Associated Themes	Description	Examples
Work Practice	External Requirements	External factors that impact the way a project, program, or task has to be completed	"A lot of times there's already standards and regulations and things like that around the device so you're kind of -- you've already got like 80 percent of your requirements are set by some governing body."
	Documentation	Objects and norms used as shared reference points for work practices	"We have to have meeting minutes. These need to be documented. We have to have all these decisions. If there's an email that a decision was made on, save that email, put it on the server. We need to understand how we got here."
	Conforming	Enforcement of similar work practices	"Sometimes I'll insist things be done a certain way. Not always. She's really good. So I never just assume I'm right. But sometimes I'll put my foot down.
	Integrating	Mutual adaption of work practice	"We had a 45-minute conversation and kinda got into that open conversation and talking to make sure we talk a little bit more so that we don't get into those situations 'cause it was just blending more towards email conversation and then those misunderstood things kick in."
	Co-learning	Joint efforts to establish common work practices	"They had a lunch meeting one time to show how to set up a new 3-D printer (…) Nobody really knew how to do it so they were just: let us have everybody get in the room and do it."
	Shared Priorities	Shared understanding of the priority and engagement	"You're essentially trying to make manageable, digestible, goals that you can reach within a set period of time. So in most projects we work on a weekly basis.

Cementation. The theme of cementation was identified as central to the formation of common ground in language use. Cementation is the deliberate strategy by organization members to use the same words and terminology to describe information, situations, and problems. Participants described how correcting the wrong use of words, adopting new terms, and building a shared language helped them share knowledge by reducing misunderstandings and ensuring similar interpretations. A sales associate at Charlie described the process of cementation:

> "*The worst in the world are the three letter acronyms(...) they are very sort of familiar, but it doesn't mean anything to me, so, so I very often have to go back and say, you know, what is that organization? Is that important? What does that mean? And when you're talking about that, and as you know, with any three letter acronym, once you get through the bullshit, there tends to be a very simple answer*"

The interviewee points out that specialized words and acronyms often hide simple concepts that are easily digestible if explained. To develop common ground in language use, participants described how it was important to ask about the meaning of terms but also expressed frustration with the use of specialized words. It was not enough to simple have a sense of what a word meant. Organization members wanted to co-create the meaning of words to reduce miscommunication and uncertainty. Cementation strategies were used by organization members as a way to mirror language use and create strong relationship with others.

Mediation. The second theme associated with common ground in language use was mediation. Mediation is the strategy of using others that have developed common language use to facilitate knowledge sharing. This was often described as mirroring language use depending who is engaged. A project manager at Alpha described mediation as follows: "*[Developers] don't get anything directly from anybody else. So I*

know if they're [employees] coming to me and they say they want the [nickname 1] changed, they want the [nickname 2] changed, I just let them [developers] know [the original name]." In the quote, the manager describes how difference in language use between groups can be mitigated by someone acting as a mediator. Using mediators help organization members ensure that information and knowledge is not lost in the interactions with others and reduces misunderstanding. Mediation strategies helps organization members interact with others, that they otherwise would have had issues engaging by using a third party that have established common language use with both groups.

Co-creation. The third theme identified in regard to common language use was co-creation. The co-creation of language played a central role in the development of common ground between organization members. Co-creation is the creation of nicknames or defining terminology together with other organization members. A human factors researcher at Bravo described how a meeting was used to create consensus around a commonly misused term: The meeting was:

> *Basically explaining a term that most of us thought that we had an understanding of. It's called heuristic review and also task analysis. That's a research term that most of us thought we had an understanding of including John and Susan who are writing these things down, the proposals. But when we go to do it, we're always like so what's the deliverable for this?*

Here the researcher explains how the co-creation of language use can help ensure that organization members know exactly what is meant by a certain task. Using meetings and interactions as way to create a common understanding of language use helped the organization members to complete their tasks and ensure that everyone involved had

common understanding. Knowledge sharing was eased when organization members were confident in what different words and concepts mean.

Common ground and interpretation. The second major category was common ground formed based on shared interpretations. Five themes were associated with the category; developing common ground, shared frame of reference; proactive engagement, co-creation, and enablement in regard to common ground in interpretations. Common ground in interpretation exists between organization members when they see and understand information and situations similarly. Common ground in interpretation eased knowledge sharing by ensure that organizational know where others are coming from and thus allow them to explore when interpretations differ.

Developing common ground. The first theme was the development of common ground through shared interpretations. The theme highlighted the requirements for the development of a common interpretation. The central factors in developing a common interpretation was to create a base understanding, provide a high-level view of projects, the reasons and rationale behind decisions, and not assuming shared knowledge. A project manager at Alpha described the dilemma of creation shared interpretations with developers and content creators:

> *It becomes difficult where they're making assumptions on what I might know. So there's the point where okay, I don't want to sound like I don't have any clue what I'm talking about, but then there's a point where I can't just say yes and then not know how to actually do something. So like not being afraid to say hey, look like I don't really understand what you're saying. Can we -- can you just go back to that for a second and kind of explain it better?*

To develop a common interpretation, it is important to challenge taken-for-granted assumptions and ensure a base level of understanding. Organization members need to have access to the same information and a clear understanding of the rationale behind

decisions. Without a shared understand organization members described situations where they would be unsure about what was important for others and thus unable to align interpretations.

      Shared frame of reference. The second theme was shared frame of reference. A shared frame of reference can be created when organization members are included early in processes, original documents are preserved, and are given continuous updates. A shared frame of reference is when organization members understand problems similarly and refer to the same documents for information and context. For example, a project manager a Bravo explains how a weekly meeting helped create a shared frame of reference:

> *We go through every project. People talk about what they're doing, how much time they're gonna spend on it. I kinda get a sense of how close they are to being done and I also hear about new projects that are starting. I might hear about an order that was placed for materials that I hadn't seen yet so all of that - listening to all of that makes sure that I have everything that I need.*

In the above, the interviewee discusses how meetings can be used to establish a shared frame of reference regarding material orders that allows him to complete the tasks that he needs. Having a shared frame of reference helps organization members understand where others are coming, their priorities, and concerns that impact their interpretation. A shared frame of reference creates the ground for common interpretations by providing organization members information early and continuously. A shared frame of reference helps organization members know who and when others have time to engage in knowledge sharing.

      Proactive engagement. The third theme was proactive engagement. Proactive engagement are the strategies used by organization members to ensure that common

interpretations exists before issues arise. Proactive engagement can be both deliberate and structured, but it can also be a happenstance occurrence. A content creator at Alpha noted that she had was able to create a common interpretation through an informal chat: "*They are introducing a new project with John. And we'll meet after and I'll be like (...) did you understand it? (...) and she will be like, no, no, no, I thought it was this, and then we'll figure it out together.*" Here the organization members point to how an informal talk with a colleague allowed her to build a shared interpretation of the next steps in a project. Moments of proactive engagement allows organization members to create common interpretations. Participants described how they probed about the needs behind requests and extra information to eliminate misunderstandings. Proactive engagement helps organization members avoid issues before they arise. By being proactive organization members are able to reduce conflicts and confusion in the execution of projects, and thus ease knowledge sharing by insure that common interpretations lay the foundations for interactions.

Co-creation. The fourth theme was the development of common interpretations via co-creation. Co-creation is when organization members come together to jointly formulate how to understand a situation or problem. Participants placed a strong emphasis on the co-creation of documents, prototypes, and solutions to ensure a common interpretation. Co-creation ensure that interpretations of information match and that the information can be acted upon. A manager at Alpha described an issue with bridging information between clients and developers:

> *We've been going back and forth for a while. We did some screen shots, like, some pictures back and forth. And we did some Excel files with some word changes and yeah, so, her and I went back and forth for a while putting something together that was what she was expecting. I'm working with her to get what her*

expectations were down on paper and then I take that, take it over to the developer. And doing it that way was much easier than trying to decipher somebody else who wrote requirements.

Here the interviewee describes how a meeting with a client helped establish what the expectations where of the software product and what was the essential features that was needed. By co-creating requirement documentation, organization members are able documents the needs and wants of others without having to guess the exact meaning of information. Co-creation facilitate common interpretations by allowing organization members to engage in dialogs that allow for exploration of differences, detailing the correct information, and the creation of common interpretations. Co-creation help knowledge sharing as the co-creation process reveals difference in interpretation while providing an avenue for correcting any deviating interpretations of information.

Enablement. The last theme was focused on how common interpretations enabled organization members to complete their tasks. Enablement is the possibilities provided by sharing interpretations. A shared interpretation enables organization members to identify deliverables, obstacles, and realistic expectations. A leading manager at Alpha described a talk with the CEO that resulted in the creation of a shared interpretation of deadlines. A shared interpretation that helped her prioritize tasks:

It has a really tight deadline. "Susan, we can't hit that deadline." Jimmy: "We don't have to have it all done by that date. We'll just get a piece of it done (...) Just focus on getting a piece it done." Because I'm freaking out over the deadline. And now he says we don't have to do the whole thing. I said okay.

Here the organizational member points out to need to understand the expectations of others, as to focus work efforts. Creating shared interoperations does not only reduce uncertainty and miscommunication, it also allows organization members to adjust their focus to what is most important to getting a project done on time. Shared interpretations

ease friction and can potentially reduce stress by ensure that organization members understand the strategic direction that the company is heading and thus better execute on tasks. The eased friction and reduced stress help facilitate knowledge sharing by ensure that organization members do not hesitate in reaching out to others.

Common ground and work practice. The third category regarding common ground focused on the shared work practices between organization members. The central factors that helped the development of shared work practices include external requirements and the documentation of best practices. Six themes were identified in the content analysis of the interviews. The themes included external requirements, documentation, conforming, integrating, co-learning, and shared priorities. Common ground in work practices helps ease knowledge sharing between organization members as it allows organization members to know when and how to reach out to others.

External requirements. The first theme focuses on the external requirements that provide a basis for shared work practices. External requirements are the rules and regulations that influence how organization members have to approach problems. Industry standards and regulations also played an important role but client and user needs were also central to the way organization members come together. An engineer at Bravo describes how regulations play a vital role in how work is conducted in the organization:

> *There's FDA requirements for all these products and there's something called a quality management system that we follow for our files so that everything's organized and can be found quickly to provide to the government or to any type of company that we're working with for their project.*

 The interviewee highlights how federal regulations dictates how him and his colleagues must organize their workflow. External requirements were a primary driver for how organization members formed common work practices. The external requirements

function as the basis for work practices and creates common ground for collaborative work. External requirements played a primary role in the three participating organizations as it helped to create common ground that was not up for discussion. The external factors determine work practices and replaces individual preferences with required approaches. In doing so the external requirements ease knowledge sharing by insure that work practices are similar across job functions and thus give organization members a sense of when and how to approach others.

Documentation. The second theme was documentation. Documentation are the objects and code of conduct used as a shared reference point for common work practices. Documentation are used to provide guidance for how to store information and document decisions. A partner at Charlie explained the importance of documentation: "*We have to have meeting minutes. These need to be documented. We have to have all these decisions. If there's an email that a decision was made on, save that email, put it on the server. We need to understand how we got here.*" The organizational member describes how documentation is used to outline rationales for decisions that can be shared with others. By having shared work practices in regard to documentation, organization members are able to backtrack and understand how misunderstandings or issues happens. Shared forms of documentation function similarly to external requirements in the way that they provide the basis for shared work practices. By creating shared work practices organization members are able glean the why and how of previous decision and thus learn from the inherent and explicit knowledge included in the documentation.

Conforming. The third theme was conforming. Conforming is the enforcement and adaptation of similar work practices between organization members. Employees will

insist on certain work practices, shared communication tools, and standard procedures in an effort to help them complete their tasks effectively. A content creator at Alpha describes the dilemma of asking others to conform to a shared work practice:

> *I'm trying to make it easier for the project managers and the developers, which are on the tech team, easier to communicate (...) And up until now, they've had their own processes, and I'm sure I'm going to get like flak for it, but I'm trying to come to a, like an easy medium. Me and Susan talked about this yesterday, about like something that makes sense for the project managers and something that makes sense for the developers.*

The interviewee describes how difference in communication patterns makes knowledge sharing difficult and that streamlining the use of communication tools can help insure that organization members have easy access to each other. Conforming to new work practices challenges the established methods and require organization members to learn new tools or processes. Organization members have to negotiation which preference that take precedent in shared work practices which can lead to conflict. Unlike external requirements personal preferences are hard to negotiate. The interviewee described how they moved careful when trying to establish new work practices as to not step on the toes of others. Conforming to difference in work practice can ease knowledge sharing by easing the access to others and thus increase exposure between two organization members.

Integration. The fourth theme was integration. Integration consist of the mutual adaptation of work practices and include the integration of task outputs and adjustment of work schedules. Integration of work practices allow organization members to optimize work flows and create work practices that benefit everyone involved. An industrial designer at Bravo described the benefits of integrating work practices as:

With the smaller one [meeting] I'll invite our project manager and then the entire industrial design team. And if not everyone can make it, that's okay. But for the larger internal review it's -- we want everyone in it kind of thing because we want to make sure that everyone has their eyes on it. And that's usually because a decision is being made from that. So after having some of these smaller internal reviews we get to a point where, you know, this is what we think we're going to show the client. Let's get everyone's eyes on it so everyone's sold on it and we can all agree that that's the direction to head in.

Continuous engagement between organization members are vital for establishing common ground. To complete projects, organization members at Alpha and Bravo both described how they needed to continuously reach out to others to ensure that tasks would be done on time and that the output of the tasks fits what others need. Organization members drew on each other to form common work practices as way to ease the completion of projects. Integration allow for task outputs to be specifically designed for others to continue the work.

Co-learning. The fifth theme identified was co-learning. Co-learning are situation where organization members come together to jointly learn and explore how to solve problems. For example, participants described how co-completion of tasks, 'lunch and learns', and mentoring helped establish common work practices. When organization members come together to learn, they create shared approaches to the completion of tasks. For example, a participant noted how mentoring helped her get a better sense of how to complete tasks: "*We would edit it together. So, she, she would show me what she is doing differently, so I could understand, or know what to look for the next time I'm editing the work.*" Co-learning and shared completion of tasks ensures that best practices are developed between organization members. Co-learning are joint efforts to establish common work practices. As common work practices are established through co-learning, organization members become intimately aware of others other strength and weaknesses

in completing tasks, and thus know who to reach out to when engaging in knowledge sharing depending on the need.

   Shared Priorities. Lastly, the sixth identified theme was shared priorities. Shared priorities are the alignment of. Shared priorities dictate the workflow of organization members, such as goals and deadlines, and ensure that tasks in a project can be passed along with minimum delay. Shared priorities are the deadlines, time commitments, and priorities between organization members. A project manager at Bravo describes how shared priorities are needed for medical device product to be shipped on time:

> *Making sure that there are certain expectations of this needs to be done so we can get it out the door by this date because we need to think about other aspects that you might not be thinking about. Like manufacturing, they want to get a product out by a certain date. They need it to be manufactured (...) I want to make sure that the industrial design team understands that if they make any changes to other components (...) that's going to add time which means taking away time from us.*

Understanding tasks that others have to complete can help to create shared priorities and deadlines. Being able to understand how others work, helps organization members to create shared work practices that facilitate knowledge sharing. As organization members develop common ground, the hand off of tasks is eased and the risks of delays are reduced. Shared priorities align the goals of organization members and ease collaboration, and thus make it more likely that organization members are willing to engage in knowledge sharing.

Summary of Findings

   Combining the quantitative and qualitative results suggest that positive multiplex relationships exists between knowledge sharing, awareness of difference, common ground, and familiarity ties. Table 20 provided an overview of which hypotheses were accepted. Knowledge sharing networks at company Alpha, Bravo, and Charlie were

characterized by sparsely connected employees that engaged in knowledge sharing within clusters. The qualitative results highlighted the complexity with which ties are formed. Awareness of difference allows employees to understand where others are coming from and lay the foundation for common ground. Awareness of difference helps employees reach out to those people that can help them solve their problems. In this regard, building common ground was shown to be a challenge as organizational member have their own preferences. The formation of common ground was primarily seen as the result of regulations and procedures. Creating common ground based on individual work practices was perceived as contentious. To create common ground organization members need to establish a common goal such as an improved workflow. Being aware of differences and building common ground allows organization members to know who and how to reach out to others for knowledge sharing.

Chapter 6: Understanding Multiplex Ties and Knowledge Sharing

"*She was a real proponent of putting us all in the same room. That way we always knew what was going on with each other's projects and it was really easy to just talk back and forth, get a quick opinion.*" – Industrial Designer at Bravo

The following sections discuss the quantitative and qualitative results with the aim to expand our understanding of how knowledge sharing unfolds in small- and medium-sized organizations focused on providing knowledge intensive services. The quantitative findings provide generalizations across the three participating organizations, while the qualitative findings provide nuance and enable descriptions of the strategies and paradoxes facing organization members engaged in knowledge sharing. The incorporation of both quantitative and qualitative results follows a mixed methods approach, as the aim is to map the knowledge sharing ties between organization members while uncovering the strategies used to engage in knowledge sharing. First, the structure of knowledge sharing ties is discussed while exploring how familiarity eases knowledge sharing. Second, the relationship between awareness of difference and knowledge sharing is examined. Third, the relationship between common ground and knowledge sharing is explored. The focus is on explicating the challenges that organization members face in forming knowledge sharing ties and how awareness of difference and common ground facilitate knowledge sharing. Next, the dynamics between awareness of difference and common ground is explored in relation to knowledge sharing. Building on this interwoven summary of the dissertation research, the final sections of this chapter reflect on the key themes of the dissertation, consider some of the limitations of the research presented, and look forward toward next steps in this body of research.

The findings from this dissertation support the notion that a statistically significant and positive multiplex relationship exists between knowledge sharing, familiarity, awareness of difference, and common ground ties. The results showed that knowledge sharing ties are likely to be formed between organization members that often communicate with each other. Similarly, organization members are more likely to share knowledge if they are aware of differences in language use, interpretation, and work practices. Lastly, the results indicate that knowledge sharing ties are likely to be formed between organization members that have develop common ground in language use, interpretation, and work practices. The content analysis revealed how awareness of difference helps organization members understand who they can reach out to for knowledge and what question to ask. Being aware of differences provide the foundation for knowledge sharing ties to be formed. At the same time, common ground helps to ease the knowledge sharing between organization members by providing shared understanding of potential solutions and conflicts. Common ground between organization members ease knowledge sharing by lowering the time and effort needed to engage with others, while awareness of difference guides organization members in who and how to reach out to others.

The Structure of Knowledge Sharing

The results of the quantitative analyses showed that organization members at Alpha, Bravo, and Charlie were unlikely to form knowledge sharing ties. When the organization members formed knowledge sharing ties, they were likely to be formed in clusters. As such, the formation of knowledge sharing ties exhibit signs in the network structures that indicate a deliberate process in the way organization members engage in

knowledge sharing. The organization members only turned to a select few in the organizations. The formation of knowledge sharing ties is a deliberate process, as organization members form relatively few ties within cluster formations. Organization members evaluate who to turn to receive information based who they know and the expertise they hold. The findings provide an insight into the balance between specialization and integration of organization members knowledge. Barley et al. (2017) reviewed the knowledge sharing literature and revealed a strong emphasis on the mechanisms that help integration knowledge between organization members. The focus in the academic literature is reflected in the way organization members form few knowledge sharing ties.

Organization members are unlikely to engage in knowledge sharing and thus the integration of knowledge. However, the findings challenge the degree to which integration of knowledge is needed to provide knowledge intensive services. The observed organizations had clear distribution of tasks between work functions that minimized the need to integrate knowledge. The focus of organization members was on integrating the workflow between organization members, understanding what others need and adjusting task outputs to match them in an effort to complete projects. Organization members used their knowledge to evaluate and take action based on information provided to them by others (Davenport & Prusak, 2000).

The observed knowledge sharing ties in the three participating organizations suggest that organization members rarely engage in the integration of knowledge, as they focus on integrating the output of their knowledge intensive labor. As such, specialization plays an important role in the production of knowledge intensive services with integration

of knowledge playing a secondary role. The central challenge for organization members is the integration of tasks so as to complete projects for clients. In this regard, familiarly between organization members formed the basis for strong knowledge sharing ties to form.

Familiarity and knowledge sharing. Hypothesis one proposed that the familiarity between organization members was positively related to the formation of knowledge sharing ties, as familiarity helped organization members to know each other's expertise. The hypothesis was supported as a significant and positive relationships was found between familiarity and knowledge sharing. Being in the same room, talking face-to-face, or using electronic communication technologies provides a basic avenue for knowledge sharing to exist. Participants described how being in the same meeting helped to understand others' mannerisms, expertise, and workflow. Exposure between organization members enables an awareness of difference and identification of common ground. However, becoming familiar with other organization members can be a challenge due to difference in communication habits.

Organization members have difference preferences for use of communication technologies that impacts how others are engaged. For example, participants described how they had to adapt or compromise with others' technology choices. A project manager in Alpha described a work arrangement he had developed with someone else: "*We have this working relationship where immediate communications are done via teams, like Kevin's style. Any program updates or execution steps are done via email because of my style.*" As organization members become familiar with others, they develop an understanding of the best ways to reach out in an effort to integrate tasks.

Understanding the work practices of others was seen as important. The participants described how communicating with other organization members required an understanding of the preference for communication, as it could help increase the response rate, lower the time spend waiting of replies, and reduce miscommunication.

Being exposed to and familiar with other organization members helps create a foundation for knowledge sharing. The finding informs our understanding of knowledge as existing between a continuum of explicit and tacit knowledge (Lam, 2000). Familiarity between organization members can help to slowly move knowledge from a tacit to explicit state. It is through the exposure between two organization members that the 'sticky' characteristic of knowledge can be broken down and passed on to others. The results reveal that it is not necessarily the joint engagement between organization members that ease knowledge sharing. The findings thus expand upon the concepts of tacit and explicit knowledge (Brown & Duguid, 2001; Dougherty, 1992) by highlighting the mechanisms by which tacit knowledge becomes explicit and sharable with others.

The simple exposure between organization members such as attending the same meetings can help loose tacit knowledge and thus ease knowledge sharing. Familiarity between two organization members reduces uncertainty about how the other behaves and the type of task output that they need. Additionally, the knowledge sharing processes described by the interviewees also placed an emphasis on the interactions between organization members as an extraction of knowledge sharing from member to another. This challenge the assumption of knowledge sharing as a continuous two-way exchange between organization members.

Mutuality and knowledge sharing. Hypothesis two posits that knowledge sharing ties are likely to be reciprocated between organization members. The hypothesis was not supported as the ERGMs run for each of the organizations showed that reciprocated formations of knowledge sharing ties were neither statistically likely or unlikely to form in the organizations. This finding challenges the assumption that knowledge sharing is a mutual dialog and engagement between organization members (Kuhn & Jackson, 2008). The observations revealed how knowledge sharing was a dynamic and dyadic interaction between organization members but that the focus of the conversations often leaned to the retrieval of knowledge from a single party.

Knowledge sharing interactions were characterized by a single organizational member seeking to engage with someone's expertise. The participants described how they reached out to other organization members with goals in mind for obtaining specific knowledge. In this regard, a dialog is important in creating efficient knowledge sharing as the back and forth between organization members allow for a narrowing process to take place. The narrowing process consists of the knowledge seeker homing in on the expertise held by the other. Knowledge sharing has to be based on a dialog because it allows organization members to probe about the essence of the knowledge sought and to clear miscommunication as the conversation unfolds. A two-way dialog is needed for knowledge seeker to get the expertise needed, while the knowledge holder needs to disentangle what the seeker wants. However, knowledge sharing should not be seen as a process that is reciprocated in nature as the primary focus of knowledge sharing interactions is for one party to seek knowledge of the other. The concept of knowledge sharing therefore places on the emphasis on the relational aspects of knowledge sharing

but should not be understood as the reciprocated exchange of knowledge. Knowledge sharing engagement may help raise awareness of differences but are rarely characterized by a mutual exchange of expertise.

Awareness of Differences and Knowledge Sharing

Hypotheses three through six examined the awareness of difference between organization members. Awareness of difference was found central to the formation of knowledge sharing ties. As awareness of difference increases between organization members so does the perceived quality of knowledge sharing. The quantitative results provide insights on the process behind the formation of knowledge sharing ties. The formation of knowledge sharing ties are impacted by organization members' awareness of others' differences. Being aware of differences helps to guide organization members to those that hold the expertise needed to complete the tasks at hand. This support the core aspects of transactive memory theory; specifically, this finding build on the notion that communication between organization members can help to uncover who knows what by making visible the difference between individuals (Hollingshead & Brandon, 2003; Wegner, 1995). Mutual engagement and development of familiarity between organization members helps uncover who are experts in what and how to best engage those members' expertise. As awareness of differences is increased, organization members are able to better distinguish who are the most knowledgably on specific topics and, thus, ease knowledge sharing.

Organization members described how they rely on others' expertise to accomplish goals without the need of a mutual understanding of expertise. By relying on others organization members are able to minimize the need for developing their own expertise

in new domains. However, being aware of other organization members' expertise is an important and necessary factor in order for knowledge sharing to take place. Organization members need to be aware of difference in expertise. Knowing who knows what is a foundation that allow organization members to reach out the right experts (Treem, 2012; Treem & Leonardi, 2015). To engage in effective knowledge sharing, organization members needs to be able to understand the unique language use of the expert, the way the expert think about a problem, and the way that others go about solving problems. Organization members need an awareness of difference in regard to language use, interpretation, and work practices. The following section focuses on how awareness of difference in regard to language use, interpretation, and work practice influences knowledge sharing.

Language use and knowledge sharing. Understanding the language use of other organization members can increase the quality of knowledge sharing. Hypothesis three posits that awareness of difference in language use was associated with the formation of high-quality knowledge sharing ties. The results show that higher awareness of difference in language use is statistically and positively associated with the formation of higher quality knowledge sharing ties. Being aware of difference in language use enables organization members to effectively engage in knowledge sharing with others. When organization members are aware of difference in language use they are able to distinguish when new terminology is used and probe into the meaning of words.

Awareness of difference in language use allows organization members to clarify discussions about concepts, solutions, and problems. In doing so, being aware of differences in language use help organization members identify divergence in

understanding and helps establish boundaries for expertise. Participants described how they were selective in trying to understand unknown terminology, as they trusted other organization members to execute tasks that they were experienced with. Thus, being aware of differences in language use is used to distinguish who holds what expertise. As such, the use of terminology becomes a way for organization members to signal their expertise and interest in projects and tasks.

The language use of organization members was additionally used to determine the emotional position of others. Organization members would use verbal and non-verbal cues to establish the seriousness of a problem or the ease with which a task could be completed. For example, one organizational member described how he would pay attention to word usage to gauge the satisfaction of clients. Awareness of difference in language use is vital for effective knowledge sharing to take place, as it enabled organization members to gauge potential issues, misunderstandings, and areas of expertise without necessarily understanding the specific terminology used. Language use acts as a signal that communicates the knowledge, expertise, and focus areas of organization members.

The findings suggest that the language challenges (such as difference in vocabulary) faced by organization members can be mitigated by developing an awareness of difference in language use. Focus must be given to the mechanisms by which organization members can anticipate difference in language use and thereby allow for the tailoring to accommodate differences. Knowledge sharing requires organization members to anticipate others' communication and to adjust their own communication accordingly.

Awareness of difference is an initial step that allows organization members to adjust their language use to match others and thus ease knowledge sharing.

Interpretation and knowledge sharing. Hypothesis four proposed that higher awareness of difference in interpretation was related to higher quality knowledge sharing ties. The results support the hypothesis as a statistically significant and positive association was found between awareness of difference in interpretation and knowledge sharing ties. If organization members felt they were able to follow the logic of how others understand information and situations, they were more likely to have stronger knowledge sharing ties. The participants described how developing awareness was important for knowledge sharing, such as advocating for a shared space to increase indirect learning. However, building an awareness of difference was also described as a process that involved exploring differences.

Organization members would seek out others that they knew held different opinions to test their own understandings. In doing so organization members told about situations where they explicitly conveyed differences in interpretation. As one participant described, "[I] *want Jamie to know where I'm coming from and I want to know where he's coming from (...) we can both see each other's side of it and maintain like respect throughout.*" Being aware of differences in interpretation help organization members gauge were others are coming from when reaching out for knowledge sharing but also hold the potential to lead to conflict.

The interviews revealed that organization members across the participating organizations often developed and explored differences in interpretation through the joints effects to accomplish tasked. However, as organization members work together

differences in interpretation are exposed and conflicts arise. Several strategies were used to handle a growing awareness of differences in interpretation. Organization members described how they would adapt their own work as to ease integration with others while others described giving up on trying to understand where others are coming from. Building an awareness of difference in interpretation was described as important because it allows organization members to follow the logic with which others engage problems.

The differences in interpretation between organization members is often driven by unconscious tendencies and taken-for-granted assumptions that can lead to contradictory interpretations of information, problems, and situations (Edmondson & Harvey, 2017). If organization members' interpretation of information diverges and remain unconscious conflicts can arise. Being conscious about differences in interpretation provides an avenue for resolving conflicts and thus ease the goal challenges faced by organization members. The findings therefore expand our understanding of the criteria needed for knowledge sharing ties to form between two organization members. Being aware of difference in interpretation can reduce misunderstandings and conflict.

Work practice and knowledge sharing. Hypothesis five stated that knowledge sharing ties are more likely to be formed between organization members that are aware of their differences in work practices. The findings from the QAP analyses support the hypothesis as a statistically significant and positive association between awareness of work practices and knowledge sharing quality was found. Organization members described how developing an awareness of difference in work practice built upon both awareness of others' language use and interpretations.

Previous engagements between organization members build the foundation for an awareness of difference in work practice. As organization members come together to solve problems, they develop a better understanding of the ways with which others approach problems and their obligations that are external to the joint engagement. For example, a project manager in Alpha described how reading the code of a developer slowly increased the managers understanding of how he approached problems. As awareness of difference in work practice builds, situations arise were organization members must decide whether to accept differences and tackle those differences through compromises. An organizational member described how he would state a lack of experience with the type of work as a way to tackle coming onto a new project where specific work practices had already been established.

On the other hand, strong awareness of difference in work practices was described as enabling specialization between organization members. Awareness of difference in work practice help develop a bond of trust between organization members. A trust in other organization members' ability to approach and deal with tasks and issues in a satisfying manner. Differences in practice leads to issues about organization members' professional identity, "us versus them" attitudes, perceptions of prestige and status, and how work is evaluated. Being aware of difference in work practice can help ease the work practice challenges that organization members face when engaging in knowledge sharing. As organization members develop an awareness of differences in work practices, they are able to anticipate issues in deadlines and workflows before they arise. Organization members are able to know when and how to approach others for knowledge sharing.

Development of Common Ground and Knowledge Sharing

Hypotheses six to eight examine the relationship between development of

common ground and knowledge sharing among organization members. Common ground

is important for the formation of knowledge sharing ties. As common ground in language

use, interpretation, and work practices increase, so does the perceived quality of

knowledge sharing. The quantitative and qualitative results suggest that common ground

help organization members ease knowledge sharing. The qualitative findings revealed

that common ground creates shared expectations, deadlines, and approaches that help

organization members come together to solve problems. Participants described how

common ground helps build a better understanding of the language, interpretation, and

work practices of colleagues.

The findings follow the tenets of communities of practice, as organization

members are part of a larger social context, which brings attention to how interactions

with other organization members facilitate and shape knowledge development. As such,

shared practices can be seen as central to the facilitation of knowledge sharing among

organization members. It is through the repeated interactions between organization

members and the aware of differences that help common ground to form. The following

section focuses on how development of common ground in regard to language use,

interpretation, and work practice influences knowledge sharing.

Language use and knowledge sharing. Hypothesis six proposed that knowledge

sharing ties were likely to be formed between organization members that share common

language use. The quantitative results support the findings as a statistically significant

and a positive association was found between common ground in language use and the

quality of knowledge sharing ties between two organization members. For example, the interviewees described how they strived to adopt terminology used by others to ease their interactions and reduce misunderstandings. The alignment of terminology and language use was described by participants as easing communication by reducing the context needed to be shared. Organization members aim to cement language use by engaging in conversations and meetings that explicate concepts and terms.

Common ground in language use is created through co-creation between organization members. However, organization members also described how they would adjust their language use depending on who they were reaching out to. For example, one organizational member described how he acted as a bridge between groups of employees that each had they own unique terminology for projects. The organizational member would help translate the communication between two groups as to ease knowledge sharing. As such, each group would be aware of each other's use of names for projects but would remain to use their own. Generally, the creation of common ground in language use was seen as difficult to reach by the interviewees, as they often perceived differences in language use as a reflection of their expertise. Thus, common ground in language use was seen as in potential conflict with being an expert.

This finding complicates the implications of prior research, which suggests that common language use eases knowledge sharing. The findings support the notion that knowledge held by organization members becomes accessible and valuable when organization members are able to speak the language of others' area of expertise. Organization members must speak the language associated with others' area of expertise to effectively share knowledge. Developing a common language use gives organization

members the freedom to engage in problem solving instead of trying to interpret what others are communicating. However, the development of common ground can be seen as minimizing an organization members area of expertise as they branch out to understand others. An inherent paradox exists when it comes to common language use. Organization members can ease knowledge but risk being seeing as generalist instead of an expert.

Interpretation and knowledge sharing. Hypothesis seven states that common ground in interpretation between two organization members are likely to be associated with the formation of knowledge sharing ties. The quantitative results found that organization members that shared a high degree of common ground in interpretation had higher quality knowledge sharing ties. The interviewees describe how developing a shared frame of reference requires a high degree of transparency. Organization members point out that they need access to information to understand where others are coming from. When organization members were able to understand the context of knowledge sharing requests, they were able to better articulate they own understanding. Technical requirement reports, facts used to make decisions saved in emails, and objects such as physical and online prototypes help organization members create a common interpretation. Documents and objects store explicit information that can be accessed over time and thus guide organization members in understanding previous interpretations of information and events.

Similar to language use, co-creation plays an important role in the formation of common interpretations. Documents and objects can become obsolete or miss contextual details when accessed later. Co-creation of interpretations at meetings or watercooler talks solidifies shared interpretations of information and situations. Organization

members describe how they try to use proactive engagement to ensure that common interpretations are formed before delving into tasks or projects. For example, organization members would end conference calls with clients by summarizing the information obtained and what that meant for the completion of the project. Deadlines and the structure of task completion was seen as vital areas where common ground in interpretation was required.

Common ground in interpretation between organization members eases knowledge sharing by providing a contextual understanding of others' decisions. Moreover, common interpretations allow organization members to understand a concept from the point of view of others. Shared interpretation of information between organization members limits conflicts and ease knowledge sharing because uncertainty and ambiguity between organization members are reduced. Thus, organization members who have a common interpretation of information have an easier time engaging in knowledge sharing.

Work practice and knowledge sharing. Hypothesis eight found that a statically significant and positive multiplex association exists between common ground in work practice and knowledge sharing ties. The higher the degree of common ground in work practice, the higher the quality of knowledge sharing between two organization members. The interviewees described how common work practices often was grounded in external requirements such as specifications from the International Organization for Standardization (ISO), software protocols, or regulation. For example, the financial service firm is required to document all communication while the medical devise design company must follow ISO standards when documenting the design process. Thus,

research has often argued that common ground is an external requirement, superseding

individual preferences.

The way organization members approach situations together with others is shaped

and influenced by external requirements. External requirements set boundaries for

acceptable ways to approach problems. In doing so the external requirement becomes the

center for the formation of common ground in work practice between organization

members. This finding adds to previous research that has primarily focused on the co-

creation of work practices between organization members (Bechky, 2003; Carlile, 2002)

by highlight the external factors that frame work practices. By using external

requirements organization members are able to ensure common work practices without

the need to invoke individual preferences that others might disagree with. When common

work practices are created organization members are more likely to take advantage of

others' knowledge, as common work practices between organization members ease

knowledge sharing.

Similar to the formation of common interpretations, the building of common work

practices rests on the need for shared documentation. The documentation helps divide

responsibilities between organization members and insure that structure of work tasks can

be examined by organization members. Organization members describe how they use

process documents to gauge potential conflicts. For instance, one interviewee highlighted

how conflicts surrounding work practices can be resolved by conforming to others or

reaching a compromise - a mutual adaptation of work practices. The need for sharing

priorities was seen as central by organization members, as it was seen as easing the

formation of knowledge sharing ties. An employee describes it as "*You're essentially*

trying to make manageable, digestible, goals that you can reach within a set period of time" that can be shared with others. Organization members aimed to reduce confusion about when and how tasks can be completed by being explicit about priorities and sharing potential obstacles in the execution of tasks. Common work practices facilitate knowledge sharing by easing the workflow between organization members and creating transparency.

Awareness of Difference, Common Ground, and Knowledge Sharing

Together the quantitative and qualitative findings illustrate how awareness and common ground is tightly associated with knowledge sharing. However, the interviews suggest a hierarchical ordering to the importance of awareness of difference and common ground on the formation of knowledge sharing ties. The organization members described how awareness of difference was important for establishing contact with others. Awareness of difference allowed organization members to know who knows what and what questions to ask. The quantitative results simultaneously indicate a close association between the formation of awareness of difference and common ground ties. The concepts of awareness of difference and common ground must therefore be seen as interrelated. Awareness of difference leads to common ground, and common ground leads to new awareness of difference. The two concepts playout through a mutually reinforcing process that ultimately is anchored in the initial awareness of difference that sparks a need to create common ground.

The concepts of language, interpretation, and work practice was also described as functioning in a hierarchical function. Understanding work practices was described by the organization members as central for the development of shared interpretations. For

example, Kevin pointed out that "*if I just said make this look nice, these are the things that need to be a part of it, then they'll go sketch things and then I'll have to say, well, they can't do that and they'll say why not.*" In a similar way to how awareness and common ground reinforce each other, understanding others' work practices were seen as essential in developing an awareness of difference in interpretation and ultimately create common interpretation of information and events. Organization members must be aware of differences in deadlines, priorities, and abilities before they are able to establish a shared understanding of how best to approach a set of tasks.

Lastly, the concept of language use was often seen as an opportunity to signal expertise and create boundaries in knowledge domains. Organization members often saw language use as a way to communicate the type of tasks they were interested in engaging by establishing expertise. The language use of the organization members can thus be seen as paradoxical, as language is used to both claim and distance oneself from the execution of tasks. Awareness of difference and common language use has to be understood differently from the related interpretation and work practices concepts. Language is used as a signal for organization members to gauge others knowledge domain and area of expertise, while an increased understanding of work practices help reinforce awareness of difference in interpretation and the creation of shared interpretations.

Easing Knowledge Sharing in Organizations

In summarizing the overall contributions of this research, this dissertation took a mixed methods approach to understanding the type of relational ties between organization members that could ease knowledge sharing. It was found that the quality of knowledge sharing ties were associated with the degree to which two organization

members had formed strong awareness of difference and common ground ties. Specially, awareness of difference and common ground in regard to language use, interpretation, and work practice were examined and found to have a positive and statistically significant impact on the existence of knowledge sharing ties between organization members.

The qualitative results found that awareness of difference allows organization members to understand where others are coming from and lay the foundation for common ground. The interviews with organization members emphasized understanding where others were coming from, as essential to engaging in knowledge sharing. As such, building an awareness of difference in language use, interpretation, and work practice creates the foundation for common ground to emerge between organization members. Awareness of difference helps organization members reach out to those that can help solve problems by indicating who hold what expertise. In this regard, building common ground was found to be a challenge as organizational member have their own preferences in work practices. The formation of common ground in work practice was primarily seen as the result of regulations and procedures. Creating common ground based on individual work practices was perceived as contentious with organization members evoking client needs, regulation, and best practices to form common ground. In this regard, the awareness and development of common work practices often have a strong perceived influence on the formation of shared interpretations.

Awareness of difference and common ground in language use was not described as influential on the formation of awareness or common ground ties. Organization members described language use as a way to communicate ownership and interest in

tasks. Organization members used language as a way to signal expertise with the development of common ground potential resulting in organization members being perceived as generalists. In this regard, difference in language use was often used to identify others area of expertise. The development of common ground was perceived by some of the interviewee as signaling a dilution of their expertise. The following section explicates the theoretical and practical implications of the findings. An emphasis is given to the relational aspect of knowledge sharing and how the findings affirms and challenges previous assumptions about knowledge sharing in organizational contexts.

Theoretical Implications

The findings of this dissertation highlight the tacit nature of knowledge sharing (Nonaka & von Krogh, 2009). Being familiar with other organization members is important for the formation of knowledge sharing ties as it can help loosen the 'stickiness' of tacit knowledge. This suggest that strong relational ties are required for knowledge sharing ties to form. Strong relational ties are important for the formation of knowledge sharing ties, as awareness of difference help organization members identify who knows what while common ground guide how and when to reach out for engaging in knowledge sharing. However, the establishment of knowledge sharing ties between organization members is often challenging. Organization members were found to be selective in the formation of knowledge sharing ties and often formed ties within clusters with few employees acting as bridges. The formation of knowledge sharing ties requires strong relational ties between organization members as it increases exposure of difference. An awareness of difference that can lead to the development of common ground.

Knowledge sharing is often seen as a dynamic and reciprocated process (Kuhn & Jackson, 2008) but the results suggest that the understanding of knowledge sharing as an inherently reciprocated process may have to be rethought. Analyses of the knowledge networks from the three participating organizations indicated that knowledge sharing ties were unlikely to be reciprocated. However, the interviews and observations revealed that dynamic conversations between organization members are important, as the open engagement provides the option for clarification of concepts and terms used doing the knowledge sharing engagement. Similarly, the quantitative results suggest the importance of strong relational ties. Using the term knowledge sharing should therefore be used to place emphasis on the relational nature of knowledge while also highlighting the importance of tacit and indirect nature of knowledge sharing (Kuhn, 2014; Kuhn & Jackson, 2008; Orlikowski, 2002). As such, knowledge sharing can be said to continuously take place both consciously and subconsciously, but is primarily manifested in deliberate interactions where knowledge flows from one organizational member to another.

The results also inform transactive memory systems (Hollingshead & Brandon, 2003) as they highlight how awareness of difference in language use, interpretation, and work practice help organization members know who knows what, and equally important, what questions to ask them. The organization members from the participating organizations described episodes where their notice of difference in language, interpretation and work practices provided opportunity for exploration of identified differences. One organizational member described as: "*I learned quickly that instead of pointing out flaws I should have been asking them reasons why. And to understand their*

thought process leading into their choices." Being aware of differences between organization members provides avenues for exploration that equip organization members to ask insightful questions to other organization members in later interactions. By being aware of difference organization members map the potential domains of knowledge that others hold. For example, content creators at Alpha described how their joint engagement on projects with developers allowed them to better understand what features that would be possible to develop. The content creators at Alpha did not hold technical expertise but they became aware of the potential features that could be implemented by developers through joint engagement. The results expand the theory of transactive memory systems by pointing to the importance of knowing what questions to ask in addition to knowing who to ask. It is through the observation and exploration of differences that organization members glean information about what knowledge others hold and how the knowledge can be beneficial.

Additionally, the results expand upon the communities of practice theory by highlighting the hierarchical order of influence between awareness of difference and common ground as described by the organization members. The theory posits that knowledge is shared through repeated interactions between organization members. The interactions between organization members are said to ease knowledge sharing by giving mutual exposure and engagement (Lave & Wenger, 1991; Wenger, 2000). Awareness of difference acts as the catalyst for exploration, as organization members come together to solve problems. The explorations that results from awareness of difference hold the potential to development into common ground between organization members – a community of practice as Wenger (2000) would coin it. A hierarchy was also described

by the organization members regarding the concepts of interpretation and work practice. Developing an awareness of work practice was seen as essential for understanding differences in interpretation.

By understanding others' deadlines, priorities, and approaches, organization members are able to better understand the rationales behind someone else's interpretation. Common for the interaction between the concepts is a reinforcing mechanism. For example, complete awareness of difference is not required for common ground to be developed nor is such an aim possible. As common ground is developed between organization members, new differences are exposed. Thus, the interaction mechanism between the concepts is characterized by a reinforcing dynamic between awareness and common ground, as well as work practice and interpretation. In this regard, the concept of language use stood out as organization members described how language use was used to signal expertise and establish boundaries with others. Language use can be seen as the starting point for an exploration of differences in work practices and interpretation. Despite a hierarchical nature between language use, interpretation, and work practice the relationships between the concepts must be understood as dynamic and reinforcing. The relational ties that ease knowledge sharing are characterized by reinforcing mechanisms, as the multiplex relationship between awareness of difference, common ground, and knowledge sharing builds and feeds upon each other.

Lastly, the findings suggest how organization members can overcome language, goal, and work practices challenges (Carlile, 2004) by developing awareness of difference and common ground. Especially work practice challenges were identified by organization members as obstacles for knowledge sharing. Work practice challenges are

based on the different and competing work practices that exist between organization members. Organization members described how developing common ground helped solve goal challenges as shared work practices eased the alignment of interpretations. In regard to language challenges, the results suggest that difference in language use is one of the easiest challenges to overcome as organization members would use language difference as indicators of expertise.

Together the findings paint a picture of knowledge sharing as deeply rooted in communicative interactions between organization members. It is through relational ties between individuals that knowledge sharing ties are formed. Despite a strong emphasis on integration of knowledge in the academic literature, the qualitative results indicate that specialization is the predominant way for organization members to provide knowledge intensive services. The finding may be the result of the challenges organization members have experience when trying to integrate knowledge across work functions. In the three observed organizations, the major challenge was the integration of work tasks to ensure that outputs of work could easily be picked up by others and further developed. As such, the results suggest that task integration are required to be aware of where others are coming from and the way that they work. Awareness of difference becomes a tool for organization members to identify others expertise, while common ground helps ease knowledge sharing by ensuring task outputs can be integrated across experts. Awareness of differences is sufficient for effective knowledge sharing with common ground between organization members being helpful in reducing complications and delays. The findings therefore point to the need for specialization by organization members due to the complexity of the knowledge intensive services provided while integration of knowledge

was seen as beneficial but unnecessary. In this regard, task integration was described by interviewees as more important than knowledge integration.

Practical Implications

The results of the analyses provide a view into how relational ties between organization members can impact knowledge sharing. The findings suggest that knowledge sharing ties are formed selectively and with care. Organization members do not develop strong knowledge sharing ties haphazardly and have a tendency to seek out those they are familiar with. These tendencies manifest themselves in the network by the formation of clusters. Clusters in knowledge networks can be understood as insolated groups that are tightly connected with few members of the group being connected to individuals from other groups (Wasserman & Faust, 1994). For example, content creators in Alpha were more connected then the group of developers. In the medical device design company, designer and engineers were more tightly connected as separate groups while having ties crossing group boundaries. As such, clusters in the network can be understood as the formation of communities of practices (Wenger, 2000). The tightly connected groups have developed common practices while remaining aware of differences to other groups. Groups that have interactions with other groups have been found to have improved performance measures (Ancona & Caldwell, 2009; Ancona & Caldwell, 1992). As such, the aim of organizations that seek to improve knowledge sharing must be to increase familiarity between organization members and insure that ties are formed that span across groups, projects, and functions in the organization.

The results indicate that the foundation for knowledge sharing is the existence of strong ties between organization members. Familiarity and indirect exposure between

organization members were found to have a positive and statistically significant impact on the quality of knowledge sharing ties. As organization members engage in joint engagements or overhear conversations at watercoolers, situations are created that allow for the exploration of differences. For example, differences in language use provides instances for organization members to identify and explore differences in expertise.

To effectively work together on projects and bring expertise into play organization members have to seek common ground. An interplay exists between awareness of differences and common ground, as each reinforces the other. Awareness of difference serve as the starting point for the development of common work practices and interpretations. As organization members create common work practices with others, new differences are identified. Awareness of difference and common ground was both found to be positively and statistically significantly associated with knowledge sharing ties. To foster knowledge sharing between organization members, support can be given to the exploration of difference while ensuring common work practices.

Limitations

The way in which the social network ties between organization members was captured comes with several limitations. An initial question was asked so as to broadly capture the relationships that exists surrounding knowledge sharing. The results of this study can thus be said to refer to knowledge, expertise, and advice contexts. The usage of a tie selection question limits insights of the findings to those relationships that represent strong knowledge sharing ties. Additionally, the use of an initial question to identify relationships impacts the social network analyses as the co-variance between different types of relational ties are limited to those ties that are related to strong knowledge

sharing ties. This can especially impact the QAP analysis as only ties related to knowledge sharing were captured. Thus, awareness of difference and common ground ties between organizational members that did not share knowledge were not captured. The way the data was captured can therefore reinforce tendencies of multicollinearity by focusing on the ties surrounding knowledge sharing relationships. The study's findings should therefore be seen as a piece of the puzzle to understand the communication patterns between organization members, especially the ties that surround strong knowledge sharing and advice ties.

The study contained data from three small- and medium-sized organizations on the East Coast of the United States. Each organization represents a single case. The participating organizations were focused on knowledge intensive services, but each had their unique characteristics. Alpha was dominated by the dispersed geographical location of employees except for the co-location of newcomers to the organization, Bravo was characterized by a focus on combining design and engineering with few managers, while Charlie was centered around partners and employee being closely related through family ties. Tendencies that was found across the organizations gave generalizability to the results. However, the size, location, and knowledge intensive service focus of the participating organizations places limitations of the generalizability of the findings. For example, the qualitative findings suggest that task integration is more valued than knowledge integration. As such the analyses provide indicators for how knowledge sharing unfolds in small knowledge intensive companies in the east coast of the United States but can be used as a springboard for further examination in other contexts. The results found in this dissertation may not hold true in larger organizations or less

knowledge intensive industries where knowledge integration may play a more important role for knowledge sharing.

Data collection was limited to a cross sectional examination of the knowledge sharing ties between organization members. The data contained interval level network data that goes beyond traditionally binary measures but did not capture longitudinal data points that could help provide causality to the findings. An additional limitation of the data is the lack of performance data to compare against the mapped knowledge sharing, awareness of difference, and common ground networks. As such, the data represents the perceptions of organization members themselves without external validation. Using perceptions of organization members therefore limits the data, as it is not possible to determine if the relations perceived to facilitate knowledge sharing also increase the knowledge of organization members.

Lastly, the examination of the data based on ERGM, QAP, and product-moment correlation also suggested a strong multicollinearity in the data. This raises questions regarding the validity of the survey data and whether the same concept is being measured. Examination of the data suggest that the multicollinearity may not be the results of the survey measuring the same concept or lack of attention from the participants when filling out the survey. The results may be due to strong multiplexity between the knowledge sharing, awareness of difference, and common ground ties. Multicollinearity can be an indicator of strong correlation and multiplexity between awareness of difference, common ground, and knowledge sharing ties (Mansfield & Helms, 1982; Wasserman & Faust, 1994). It is important to recognize this as a potential limitation.

Future Directions

The aim of the study was to explore only a few of the potential multiplex associations that surround knowledge sharing. The results provide a glimpse into the potential relationships between organization members that can influence knowledge sharing processes. Several areas of further research emerge from the design and findings of this dissertation. A relational approach was used to understand knowledge and the type of communicative interactions that ease knowledge sharing. The use of a relational perspective highlights the multiplex nature of knowledge sharing. Multiple types of relationships between organization members impact how knowledge is shared. Taking a multiplex perspective to understand organizational communication problems can provide insights into how dyadic relationships are associated with each other. A multiplex approach to knowledge sharing holds the potential to map the communicative interactions between organization members. Capturing the communication networks in organizations allows for the examining of multiplexity but also allows for the examination of how network patterns influence organization members', for example, health and stress. Future research could benefit from examining the reinforcement mechanisms found between awareness of difference and common ground. Using longitudinal data would allow for an examination of the casual relationship between knowledge sharing, awareness of difference, and common ground.

Lastly, central to the work practices in the participating organization was the use of technology. In Alpha several types of technologies were used for communication, such as real-time audio and video tools that allowed organization members to share their computer screen with others. Organization members described how screen share was an

important feature to reduce miscommunication and ease knowledge sharing. Screen share was seen as replacing the face-to-face interactions that, for example, took place in the more traditional engineering setting of Bravo. Even within Bravo, organization members described how they would send documents such as a design draft before getting out of their chairs to go talk to a colleague. The examples highlight how organization members use technologies in unintended ways. Further research could take a affordance and visibility perspective to better understand how technology impacts and influence how knowledge sharing unfolds in organizations.

<div align="center">**Conclusion**</div>

This dissertation shows that knowledge sharing springs out of the multiplexity relationships that exist between organization members. A statically significant and positive association was found between awareness of difference, common ground, and knowledge sharing networks. A mechanism of reinforcement was found between awareness of difference and common ground, as each concept mutual builds upon the other. Here, a hierarchical order was found between language use, interpretation, work practice and knowledge sharing. Language use was found to be an important way to signal expertise, while work practice was seen as central to the development of knowledge sharing ties. Together to findings highlight the relational nature of knowledge sharing.

Appendix A:

Interview Protocol

Introduction:
Thank you so much for taking the time out to participate in the research. The interview aims to understand how you communicate and share knowledge, professional advice, with your colleagues. I am interested in hearing about your experiences and challenges with sharing knowledge. Everything you say will be kept confidential.
Semi-structured Interview Questions:

1. The following questions asks about your role in your organization, and your expertise.
   - What is your formal role/title and what type of work that you do?
   - What kind of colleagues, project, teams, or other units do you work together with?
   - How do you see the work you do as different from the work of your colleagues?
2. The next set of questions focus on differences in work practices between you and your colleagues.
   - Have you experienced situations where your way of approaching work has conflicted with colleagues, e.g. in situations when you're working with a *team*?
   - What are some of the methods/approaches/processes/"ways of doing things" that your colleagues use in their day-to-day work that make it challenging to work together with them?
3. The following questions asks about differences in interpretation between you and your colleagues.
   - Can you think of a time when you were in a situation, e.g. working with a *team*, where you saw a different solution to a problem than your colleagues?
   - What disagreement about solutions to problems have you experienced when working with colleagues in a *project*?
4. The next set of questions aim to understand the difference in language between you and your colleagues.
   - What type of professional advice do you find hard to formulate when talking to your colleagues/*team*?
   - When do you find it hard to understand the professional advice given to you when working with your colleagues in *projects*?
5. The last set of questions aims to uncover successful experiences of working together with your colleagues.
   - What are some of the conversations/interactions/dialogs/talks/meetings that have helped you better understand where others were coming from?
   - What are some of the methods/approaches/ processes/"ways of doing things" that makes it easier for you to understand others?

Appendix B:

Questionnaire

- Please provide your name below. This is a confidential survey, and although we are asking for your name, we will remove your name from the results and use a numeric identifier in its place.

  (text response)

- Please provide the city and country of your primary work office. This is a confidential survey, and although we are asking for your location, we will remove location information from the results and use distance between work locations in its place.

  (text response)

- Below is a list of current members of your company. A series of questions are asked for each colleague that aims to describe the potential interaction patterns between you and them. If the relationship does not apply, simply leave the row unchecked. Otherwise, please select the colleagues that fit with the question.

  Please identify the colleagues that has been the most important source of knowledge and expertise, whom you approach if you have a work-related issue or when you want advice on a decision you have to make.

  (text response)

The following questions was asked for each selected organizational member.

- The following statements build upon your selection of colleagues that are an important source of knowledge and expertise to you. Please indicate the frequency and intensity of that particular relationship based on your own perception.

  Please describe your knowledge sharing behaviors with **X**

  (1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly agree)
  The knowledge and expertise provided to me helps improve my work
  I can understand and put into action the knowledge and expertise provided to me
  I am able to reach out to get knowledge and expertise when I need it

- The following questions asks you to describe your familiarity with **X.**

  (1 = Hourly, 2 = Daily, 3 = Weekly, 4 = Monthly, 5 = Yearly)

  How often do you talk in-person?

How often do you find yourself in the same room?
How often do you use text-based technologies to communicate, e.g. using email/Messenger/Slack?
How often do you talk use audio/video technologies to communicate, e.g. telephone/Skype/Teams/Zoom or screen capture tools?

- The following statements describe the differences in language, interpretation, and practice between you and **X.**

  (1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly agree)

  I notice and think about differences in the words and expressions used
  I notice and think about differences in goals and interest
  I notice and think about differences in work flows and habits

- The following statements describe the commonalities in language, interpretation, and practice between you and **X.**

  (1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly agree)

  We often use the same words to describe problems and ideas
  We often have similar ways of interpreting and thinking about work related issues
  We often have similar ways of working and approaching problems

The following questions ask about participants demographic information

- Please indicate your biological sex.
  (Male, Female, Other)

- Please indicate your hierarchical position at your current company.
  (I have no management responsibility over other employees, I have management responsibility over other employees)

- Please indicate your level of education.
  (Less than high school, High school graduate, Some college, 2 year degree, 4 year degree, Professional degree, Doctorate)

- Please provide your tenure at your current company as measured in years
  (e.g. 1.5 years).
  (text response)

- Please provide your experience within your company's industry as measured in years (e.g. 5 years)
  (text response)

- Please indicate the total number of individuals that are members of the teams/projects you are currently engaged in.
  (text response)

- Please provide your educational major
  (text response)

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