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KNOWLEDGE TRANSFER METHODS BETWEEN GENERATIONS IN CONSTRUCTION AND ENGINEERING COMPANIES

by

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APPROVAL

This thesis entitled:
Knowledge Transfer Methods between Generations in Construction and Engineering Companies
written by Maryam Sanaei
has been approved for the Department of Civil, Environmental and Architectural Engineering

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Date_____

The final copy of this thesis has been examined by the signatories, and we find that both the content and the form meet acceptable presentation standards of scholarly work in the above mentioned discipline.

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ABSTRACT

Sanaei, Maryam (M.S., Civil, Environmental and Architectural Engineering)

Knowledge Transfer Methods between Generations in Construction and Engineering Companies

Thesis directed by Assistant Professor Amy Javernick-Will.

Today four generations of employees work together in workplaces. These diverse demographics can hinder knowledge flow across the organization because each generation has their own values and workplace expectations. Moreover, there is an additional issue of aging workforces which add more complexity to workplaces. Organizations realize they must effectively capture and disseminate knowledge and experience from this near-retirement cohort to incoming employees, and provide the opportunity for both older and younger employees to learn from each other. This is even a greater challenge in project-based construction and engineering industry. To address these needs, this research focused on (1) determining whether generational attributes of employees affect knowledge exchange patterns; (2) identifying the frequent knowledge sharing (KS) methods used and (3) preferred to use by each generation within communities of practice (CoPs) active in construction and engineering companies. Findings help managers to facilitate knowledge flow within CoPs across construction companies.

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CHAPTER 1: INTRODUCTION

Observed Problem

The current workforce consists of four generations of employees with different values, approaches, and preferred learning styles (Zemke et al., 2000, Arsenault 2004). These diverse demographics can reinforce organizational innovation and creativity in multigenerational construction and engineering companies. However, misunderstanding the generational differences can sometimes lead to inessential personal or organizational conflicts (Arsenault 2004) which in turn can hinder knowledge transfer across organizations. In order to reduce these challenges, managers need to have a clear perception of knowledge providers' and receivers' characteristics and the KS methods they use or prefer to use in their multigenerational workplace. Prior studied offered general suggestions on how management can facilitate knowledge transfer by considering the generational attributes of employees. Applying these strategies can help to reduce some of the unexpected problems that arise from generational differences. However, these suggestions are generic to all types of organizations and a lack of data exists for construction and engineering industry. Moreover, there is a lack of evidence regarding whether generational attributes of employees influence KS connections and whether generational differences exist for the methods used or preferred to use within their KSCs. To address this need, this research addresses the following questions:

1. Do generational differences impact knowledge exchange patterns in CoPs in construction and engineering organizations?

2. What methods do employees in CoP in multi-national construction and engineering companies actually use to (a) provide and (b) receive knowledge with others based on generational attributes?
3. What differences exist (if any) between generations in their use of different knowledge sharing methods?
4. What methods do employees prefer to use as (a) knowledge providing methods and (b) knowledge receiving methods in CoPs in multi-national construction and engineering companies?
5. Is there any difference between generations in their preferring to use different KS methods?

Contributions

For this study, we first selected three communities of practice (CoPs) active in two multi-national engineering and construction companies. We then focused on generational attributes of CoP members and their existing KSCs in each CoP. Interestingly, findings show that the attribute of generation impacts the distribution of KSCs within all CoPs studied. In addition, there was an association between generational attributes of employees and the KS Methods that they used to provide or receive knowledge in the CoPs. The most frequently used methods, personal discussion and email, were used equally by different generations. Moreover, when sufficient data was available to run statistical tests, we found a general trend and preference by younger employees to use IM. Finally, findings show Boomers preferred to use workshop as a knowledge receiving method and phone as a knowledge providing method significantly more than Gen-Ys, while they preferred to use IM significantly less Gen Ys.

Thesis Format

In this thesis, Chapter 2 is a positioned as a complete journal article that addresses the first three questions posed above. As such, it contains all components of a journal article, including an abstract, introduction, review of literature, research method, results, discussion, conclusion and references. This paper is planned for submission to the Journal of Construction Engineering and Management. Chapter 3 addresses the fourth and fifth research questions and their answers. Because the motivations, body of knowledge and methodology are similar to Chapter 2, this chapter presents and discusses the results to these questions only. Due to the space limitations in journal paper, the methodology and analysis of all research questions posed above are described in more detail in Chapter 4. Finally, Chapter 5 summarizes the theoretical and practical contributions from this research and provides suggestions for future research.

CHAPTER 2: TRANSFERING KNOWLEDGE WITHIN AND BETWEEN GENERATIONS IN CONSTRUCTION AND ENGINEERING ORGANIZATIONS

Abstract

Four generations of employees —Traditionalists, Baby boomers, Generation X and Generation Y— are now working together in organizations. This demographic diversity can provide benefits for construction and engineering organizations, but it can also hinder knowledge transfer across organizations. Because well-distributed knowledge sharing connections (KSCs) increase knowledge exchange across the entire organization, thereby enhancing performance, managers are focusing on how to facilitate these connections. With four generations working together within organizations, this research focuses on how to span generational boundaries to increase organizational knowledge transfer. Departing from the organizational learning literature, this study aims to (1) determine whether generational attributes of employees impact knowledge exchange patterns; and (2) identify the most frequent knowledge sharing (KS) methods that each generation uses to provide or receive knowledge within communities of practice (CoPs) in construction and engineering companies. Data were obtained from 734 employees within three CoPs across two construction companies headquartered in the United States. Findings show that generational attributes influence the creation of KSCs, even though survey participants rated generational attributes as not being important for KSCs. Moreover, the results indicate that there was no difference between generations in using personal discussion and email as a KS method, while significant difference was found in generations' use of instant messaging and Meeting. Identifying the methods that are equally used by different generations and the methods that are used by a specific

generation significantly more than other generations helps managers to facilitate knowledge transfer process in CoPs by providing the correct method for the correct employee.

KEYWORDS: Construction, Knowledge Management, Generation, Knowledge Sharing Methods, Knowledge Sharing Connections

Introduction

In today's highly competitive market, knowledge is considered invaluable due to the strategic advantages it presents for organizations (Choo and Bontis 2002, Stevens 2010). In organizations, knowledge can empower effective actions (Nissen 2007) through reducing repeated mistakes, stopping the reinvention of the wheel, and allowing innovation growth. As a result, knowledge sharing connections (KSC) that are well-distributed across the organization can improve performance at the individual, project and organizational level (Cross and Cummings, 2004). However, while diverse demographics can be a strategic advantage, this same diversity can also hinder knowledge transfer across the organization. One particular concern is the transfer of knowledge across generations. Today's workplaces, for the first time in the history, have four generations working together (Haynes, 2011). The United States Department of Labor reported that, in 2010, the workplace in the United States was comprised of 5% Veterans, 39% Baby boomers, 33% Generation X, and 23% Generation Y. Based on the report, 11% of the current US employed population will be above 65 —the formal retirement age— by 2017 and this number will increase to 44% by 2030 (United States Department of Labor - Bureau of Labor Statistic). With a large number of employees reaching age 65—the formal retirement age—or older, by 2017, a large portion of the existing workforce (Veterans and Baby Boomers) have begun to retire. As a result, organizations realize that they must

capture and disseminate knowledge from this near-retirement cohort to younger generations entering the workforce in order to remain highly competitive. For this reason, managers are now focused on retaining the valuable knowledge possessed by elder generations, and facilitating the knowledge exchange between generations (Stevens 2010). However, each generation grew up in a different environment and was exposed to different technologies and life events. As a result, there are expected differences in their learning preferences.

In particular, the elder generations are more familiar with formal learning methods and are reported to have a preference towards reading books and printed texts (Kapp 2007, Piktialis and Greenes 2008). On the other hand, the younger generations grew up with electronic communication technologies, prefer informal learning methods, and demand quick access to information with constant feedback (Kapp 2007, Piktialis and Greenes 2008). In order to transfer knowledge effectively between these different generations, strategies to facilitate knowledge transfer must consider the methods those generations use to provide and receive knowledge in the workplace. As a result, this study analyzes knowledge sharing connections based upon the generational attributes of employees within CoPs in construction and engineering companies. Specifically, this research analyzed the KS methods employees actually reported using within their KSCs to provide and receive knowledge.

Because knowledge exchange is necessary to remain competitive and retain knowledge of employees that will retire, organizations must develop a plan to disseminate knowledge between employees. To develop this plan, organizations must consider the preferred learning styles of different generations, which will affect how they communicate and transfer knowledge. However, although it is widely recognized as being an important challenge for

organizations, little is known about knowledge transfer based upon generational attributes of employees in construction and engineering organizations.

Point of Departure

Knowledge transfer remains a challenge for organizations, especially given the number of employees expected to retire from the Veteran and Baby Boomer generations. Although transferring knowledge, experience, and business acumen from the out-going cohort to incoming employees plays an important role in the organizational success (Kapp 2007), the most effective workplace is achieved when two-way learning occurs and both older and younger employees learn from each other (Stevens 2010). To engage two-way learning, management needs to recognize the differences that exist between generations and make diverse knowledge transfer methods available to suit different generational learning styles existing in the workforce. To uncover these differences, this research focused on KS methods used by different generations to provide and receive knowledge within multi-national construction and engineering organizations headquartered in the United States. To conduct this research, we draw from prior work on organizational learning, Social Network Analysis (SNA), and generational differences and learning styles.

Organizational Learning

The main feature of the current business environment is rapid change, which highlights the important role of organizational learning in survival and success of 21st century organizations (Chinowsky and Carrillo, 2007). Based upon the knowledge creation theory, knowledge is created through continuous interaction, including transferring and conversion,

between tacit and explicit knowledge (Nonaka 1994). It provides a theoretical framework including different modes of knowledge creation (Figure 1).

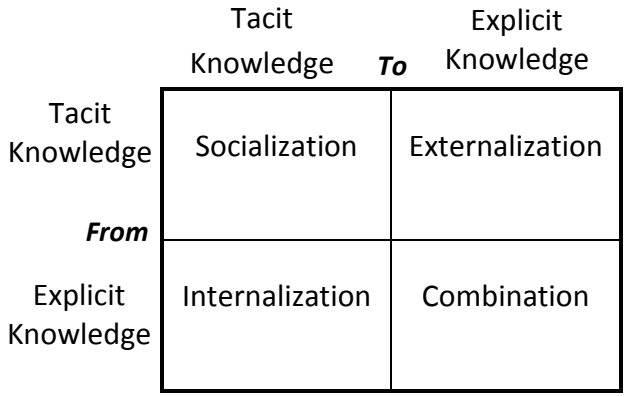


Figure 1: Modes of knowledge creation (Nonaka 1994)

As shown in Figure 1, socialization and combination are related to knowledge transfer, while internalization and externalization indicate the knowledge conversion from tacit to explicit or vice versa (Nonaka 1994). For the purpose of this research, we focus solely on knowledge transfer. Two kinds of processes are generally used to transfer knowledge in the construction and engineering industry: formal processes and social processes (Javernick-Will and Levitt 2010). Formal processes such as project databases, reports, procedures and processes focus on acquiring and sharing the explicit knowledge, especially through IT platform which in turn result in facilitating knowledge flow across the organization (Gupta and Govindarajan 2000). Social processes are used to capture and develop more tacit knowledge. Meeting, on-the-job training, mentoring, personal discussions, and transfer of personnel to exchange knowledge are examples of knowledge transfer through social processes (Javernick-Will and Levitt 2010).

Many people tend to use social processes to obtain tacit knowledge from experts; however, the processes do not always work, especially when someone has valuable tacit

knowledge, but limited time to transfer it. As a result, organizations need to employ a combination of both formal and social processes (Javernick-Will and Levitt 2010). In spite of this fact, many US companies in architecture-engineering construction (AEC) sector are more likely to use social processes for managing knowledge transfer than formal ones (Carrillo and Chinowsky 2006).

As mentioned, despite the known benefits of acquiring and transferring knowledge, challenges remain in the project-based construction and engineering industry. Specifically, the project teams are temporary and often disband after completing a project, making it difficult to share the knowledge and experience that they (teams) gained on a project (Whitley 2006). In addition, the attention and focus of employees within this industry is often on a project versus the organization as a whole. Integrating the knowledge that resides with employees and that they have gained from their experiences on projects across the organization is difficult.

Investigating the KSCs through those knowledge flows within an organization helps managers to identify the most frequent formal and social methods used by employees, determine the weaknesses of their knowledge sharing network and facilitate knowledge by providing a good combination of both types of methods. One of the primary aims of this study is to determine how generations influence knowledge flows. The research also attends to which methods generations use to transfer knowledge within the connection as well as what methods they prefer to use to provide or receive knowledge. Understanding the methods that are used and preferred can help organizations to facilitate knowledge transfer between employees.

Social Network Analysis

In organizations, knowledge exchange occurs at multiple levels including ‘‘between individuals, from individuals to explicit sources, from individuals to groups, between [within] groups, across groups, and from the group to the organization’’ (Karlsen and Gottschalk, 2003, p.113). To achieve a clear perception of how knowledge transfers within organizations, both individual connections and the network of participants need to be examined (Javernick-Will 2011). A social network is made of actors (nodes) who are connected to each other by relations (ties) (Park et.al 2011). Social Network Analysis (SNA) enables researchers to focus on interactions in networks by applying mathematical analysis to network information (Chinowsky et.al 2008). Park and his colleagues (2011) define SNA as “a methodology used to identify the conditions of social structures by analyzing the interactions and interrelationships of a set of actors” (p.345). In SNA, graphs are used to visualize relationships between two types of nodes including ‘egos’ who participate the surveys and ‘alters’ who are reported by egos. Visualization of network principles and results is the option that differentiates SNA from previous mathematical matrices (Chinowsky et.al 2008). Due to these strengths, the network analysis approach has been increasingly applied in construction field (Chinowsky et.al 2008, Chinowsky et.al 2011, Pryke 2011, Javernick-Will 2011, Di Marco and Taylor, 2011, Alsamadani et.al 2012).

Generational Learning Preferences

One generation is distinguishable from another due to shared social and historical experiences that affect the lives of each generation (Smola and Sutton, 2002). These effects include a generation’s values and beliefs, approaches to family life, gender roles, religion,

lifestyle, and authority as well as workplace preferences regarding how to lead, be led, work, and learn (Arsenault 2004). As a result, management must identify and account for generational characteristics of employees in the workplace (Smola and Sutton, 2002).

Differences exist on labels of generations, the number of generational segments, and the specific years those generations represent. This study follows Lancaster and Stillman's (2002) four-generation approach, including Veterans (pre-1946), Baby boomers (1946-1964), Generation X (1965-1980), and Generation Y (1981-1999). With Veterans retiring, the majority of the current workforce is represented by the last three generations. In the following, each of these generations is explained more in detail.

Veteran (Pre-1946)

Profoundly influenced by the Great Depression, World War II, and the Cold War (Lancaster and Stillman 2002), Veterans are generalized as patriotic, polite, hardworking, and respect work ethic and authority. They perceive work as a duty (Haynes 2011) and highly value formality (Gibson 2009). The influence of the military in their lives results in a preference for a well-defined hierarchical organizational structure, complete with a top-down chain of command, and formal relationships in workplaces (Arsenault 2004, Tolbize 2008). They tend to be loyal to institutions and respect authority.

Because Veterans were not exposed to personal computers (PCs) during their childhood, they are generally less familiar with technology and learning new technologies is typically more difficult for them (Lancaster and Stillman 2002). Because they learned to receive and process knowledge via explicit knowledge written in documents and through formal classroom settings,

their preferred learning styles involve hard copies of text and data and formal classes (Piktialis and Greenes 2008). They also tend to prefer verbal communication over visual (Wagner 2009).

Baby boomer (1946-1964)

Baby boomers – or Boomers—represent the largest population in US history (Lancaster and Stillman 2002). They represent a sharp increase in the birthrate during and after World War II, between the years of 1946 to 1964 (Smola and Sutton 2002, Glass 2007). During their critical developmental years[1], Boomers were influenced by the human rights movement, the sexual revolution, (Smola and Sutton, 2002), and dual income families (Lancaster and Stillman 2002). Due to these experiences, they are generalized as being optimistic, idealistic, workaholic and highly competitive (Lancaster and Stillman 2004, Glass 2007). Scorning traditional hierarchical structures (Arsenault 2004), boomers value leadership styles that let them participate in collaborative decision-making processes (Haynes 2011, Tolbiz 2008, Smola and Sutton 2002) and prefer sharing their knowledge with younger colleagues by mentoring them (Glass 2007).

Glass (2007) found that boomers highly value face-to-face conversations to transfer knowledge and are at ease asking questions of their peers in the office (Glass 2007). They even expect to pick up the telephone and ask their questions of a person a thousand miles away (Kapp 2007). Although Boomers did not grow up with PCs, the PC transformed their lives, creating a big chasm between themselves and the next generations. As a result, they are sometimes referred to as "Digital Immigrants" (Piktialis and Greenes 2008). Like Veterans, Boomers' prefer more structured learning methods, such as verbal and text driven materials in formal classrooms (Kapp 2007, Wagner 2009).

[1] Critical developmental years are between the ages of 5 to 18 (Glass, 2007)

Generation X (1965-1980)

Generation X (Gen X) is approximately half the population of the Boomer generation, primarily because Boomers had smaller families. Gen-X was affected by Sesame Street, PCs (Lancaster and Stillman 2002), AIDS (Smola and Sutton 2002, Lancaster and Stillman 2002, Arsenault 2004), and events that included the fall of communism, the Rodney King trial, and the Challenger disaster (Arsenault 2004). Smola and Sutton (2002) found that "Gen Xs grew up with financial, family, and societal insecurity; rapid change; great diversity; and a lack of solid traditions (P.365)". Many spent the majority of their childhood home alone due to dual income households and a high divorce rate. Witnessing their parents' layoffs in the 1980s, Gen-Xs are generalized as being skeptical, distrustful of institutions and trusting themselves more than organizations (Glass 2007). They are also described as self-reliant (Haynes 2011), independent, individualistic, and skeptical about their future (Arsenault 2004). Work/life balance is a top priority—even if this situation provides less income, Gen Xs prefer a challenging job with flexible schedules to spend more time with family (Bova and Kroth 2001). Within organizations, they are also honest, straightforward, and at ease with competition and change (Lancaster and Stillman 2002) and enjoy challenging others by asking questions (Haynes 2011).

Younger employees, including both Gen-Xs and Gen Ys are results- or outcome-oriented and do not care about how or where the work is done (Glass 2007). As a result, prior studies have cited the necessity to make "learning" meaningful to this generation by explaining why the knowledge is important and what they will able to do (the expected outcomes) after acquiring the knowledge (Bova and Kroth 2001). Gen-Xs prefer informal learning, although given their upbringing they are often comfortable with both formal and informal methods

(Piktialis and Greenes 2008). In fact, Gen-Xs typically prefer formal training only when no other option exists (Bova and Kroth 2001). Moreover, 'mentoring' is a suitable knowledge providing method for Gen-Xs (Bova and Kroth 1999).

Generation Y (1981-1999)

The latest generation entering the workforce is Generation Ys (Gen Ys). Other names for this group are Millennials (Lancaster and Stillman 2002), the Next Generation, or Nexter, and the Internet Generation (Arsenault 2004). This group grew up with the rapid expansion of technology and media. As a result, they are technically experienced and savvy, connected to the internet 24-hour a day, and demand 24-hour feedback. Gen Ys were deeply influenced by the increasing gap between rich and poor, unusual growth of immigration (Lancaster and Stillman 2002) and the terror attacks in the US (Glass 2007). They are patriotic, socially active, and team oriented. They value collaborative tasks and prefer to work for organizations that value their contributions and provide opportunities to be involved in collective decision making (Glass 2007). Similar to Generation X, they are results-oriented (Haynes 2011). And, while they also aim for work/life balance (Haynes 2011), they also prefer work that has intrinsic meaning (Lancaster and Stillman 2002). Contrary to Gen-Xs, Gen Ys are very optimistic about their future (Arsenault, 2004). While Gen-Xs feel comfortable with diversity, Gen Ys expect, admit and value a diverse workforce (Lancaster, 2004).

Gen Ys' learning styles are defined by connectivity. Growing up with modern communication technology has made Gen Ys the first "digital native" generation in the workforce who prefer to use digital messaging to face-to-face communication (Glass 2007). They are constantly connected via IMs, wikis, blogs, and podcasts (Piktialis and Greenes 2008)

and would rather use quick email and text messaging to acquire the knowledge they need (Glass 2007). They look at learning more as fun than a duty. In addition, due to rapid changes in their environments, their attention is focused more on how to learn versus what to learn (Piktialis and Greenes 2008). Because they grew up with video games, they also tend to be more visual learners (Kapp 2007). Rather than be told what to do; in the workplace, they prefer trial and error, having fun, and learning from their peers instead of authorities (Piktialis and Greenes 2008, Kapp 2007). According to Kapp (2007), some popular methods of knowledge transfer for Gen Ys are instant messaging (IM), blogs, wikis, and podcasts.

A review of the knowledge sharing literature revealed that many studies were conducted regarding of the learning preferences of each generation separately, especially for Gen-X and Gen-Y e.g. Bova and Kroth 2001, Appelbaum et.al 2005, Tolbize 2008, McNichol 2010, Stevens 2010. However, despite the need to increase knowledge flow between generations in the workforce, there is a dearth of studies that explore knowledge exchange between generations with statistically significant findings and validated results (Appelbaum 2004, McNichole 2010). Specifically, many studies either review existing literature or rely on authors' personal experience in workplaces. Although some applied more robust research methods, including interviews, questionnaires, and focus groups, additional work needs to be completed to analyze the complex intra- and inter-generational knowledge transfer process. Additionally, as mentioned before, there are no known studies specifically in the engineering or construction domain.

In order to understand how knowledge is actually being exchanged inter- and intra-generationally, we empirically studied a network in a multi-national construction and

engineering organization. To understand methods used to exchange knowledge within existing connections, we employed Social Network Analysis (SNA). This allowed the analysis of existing connections in a network. Although SNA has recently received attention from construction and engineering researchers - e.g. Chinowsky et.al 2008, Chinowsky et.al 2010, Pryke 2011, Javernick-Will 2011, Chinowsky et.al 2011, Di Marco and Taylor, 2011, Alsamadani et.al 2012- , this approach has not been used to analyze network connections based upon the generational attributes of employees. To address this need, this research addresses the following questions:

1. Do generational differences impact knowledge exchange patterns in construction and engineering organizations?
2. What methods do employees in multi-national construction and engineering companies actually use to (a) provide and (b) receive knowledge with others based on generational attributes? *And*
3. What differences exist (if any) between generations in their use of different knowledge sharing methods?

Research Method

In this study, data was collected from three communities of practice (CoPs) within two multinational construction and engineering companies headquarter in the US (Appendix 1). These companies have recently begun to create interdisciplinary and globally distributed CoPs in order to facilitate knowledge flow between employees. Wenger and Snyder (2000) defined CoP as "[a] group of people informally bound together by shared expertise and passion for a joint enterprise". The CoPs studied have employees that have elected to join the CoP due to a

common interest in the subject matter. For instance, CoP 1 is focused on sharing six sigma process control information, while CoPs 2 and 3 are focused on sharing CAD technical discipline, and transportation technical practice information, respectively. These CoPs are globally distributed across companies with members from different discipline and hierarchical levels. In this study, we focused on existing KSCs and the methods used by members within the connections in each CoP. The data collected through online questionnaires was then analyzed using both UCINET and Netminer SNA software, Relational Contingency Table (RCT), chi-square, and proportion statistical analysis. The management of each participating company provided the individual attributes of all CoP members including organizational position and geographical location. Table 1 provides details of each CoP, including the primary focus of each, the number of CoP members, the number of employees who participated in the survey who indicated their year of birth, and the corresponding response rate.

Table 1: Summary information of participating CoPs

	CoP 1	**CoP 2**	**CoP 3**
Field	Six sigma info.	CAD info.	Transportation info.
Number of CoP members	273	1157	365
Number of survey participants with known generational attribute	120	466	148
Response rate	44%	40%	41%

Please note that because this project focused on knowledge transfer between generations, employees whose birth years were unknown were removed from the analysis.

Data Collection

To begin, the research team sent the questionnaire to the members of three communities of practice (CoPs) and collected the data using Network Genie software. Network Genie is a web-based, social-network survey tool that helps researchers to design and collect social network questions and later export the data collected for network analysis. Because we had a clearly defined boundary of the network (membership in a CoP), we administered the questionnaires to the CoPs as complete networks. As a result, the survey respondents selected other CoP members with whom they have a knowledge sharing connections (KSCs) from a complete list of CoP members rather than manually entering their names. Asking all CoP members to participate the survey provided the best opportunity to reduce the bias in sampling that may arise from selective inclusion of participants. The questionnaire included person-centric questions and network questions. Person-centric questions asked respondents about their background. Network questions focused on KSCs with whom the respondent had exchanged knowledge in the six months prior to the survey, including the direction of their KSCs, and the KS methods used frequently through their KSCs. The response rate was 44%, 40% and 41%, respectively, for CoP 1, 2 and 3. Of the respondents, Table 2 lists the number of respondents according to generation.

Table 2: Frequency of generations among survey participants

	CoP 1	**CoP 2**	**CoP 3**
Veteran	0	4	2
Baby boomer	30	133	70
Generation X	74	228	56
Generation Y	16	101	20
Total	120	466	148

Due to the low number of Veterans in the CoPs, this generation was removed from the analysis of question 2 and 3 where sufficient data is required to run the statistical analyses.

Analysis and Results

The collected data was analyzed using UCINET and NetMiner, software packages developed for social network data analysis. Specifically, a statistical tool, RCT, was used to determine if generational attributes influenced the knowledge exchange patterns of each CoP, which is embedded within UCINet. The other research questions required more robust analysis of generational attributes. Because NetMiner has more powerful tools for the analysis of attributes, including building block models, a combination of NetMiner and statistical tests were used to analyze the methods used to transfer knowledge within and between generations to provide and receive knowledge. In order to avoid overlap, and because the analysis required a multi-method approach, we present the methods of analysis and results specific to each question together in each of the following sections.

Influence of Generation on Knowledge Sharing Connections

To begin the research, we assessed whether the attribute of generation influences knowledge exchange patterns in multi-national construction and engineering companies. To answer this question, we analyzed the connections within and between groups of employees when they were categorized based on their generational attributes, and applied Relational Contingency Table (RCT) analysis using UCINET. RCT enabled us to compare the observed frequencies of KSCs with the expected frequencies in a network of equal size and attribute distribution. Inequalities between observed and expected frequencies indicate that the KSCs within the CoP are affected by the attribute of interest, in this case, the employees' Generation.

In order to identify whether the difference is statistically significant, RCT applies the chi-square to test the following hypotheses:

H_0: The expected numbers of connections between pairs of generations are equal to the observed numbers of connections between pairs of generations

H_1: The expected numbers of connections between pairs of generations are not equal to the observed numbers of connections between pairs of generations

In the survey, we asked employees with whom they exchanged knowledge on job-related CoP practices in the past six months. Answers to this question, combined with each person's generational attribute, provided the observed frequency of connections within and between generations. In contrast, the expected frequency of knowledge sharing connections was calculated based upon bootstrapping 10,000 iterations of connections that would occur based upon random chance given a network of equal size and attributes. Applied to existing generations, the RCT analysis calculated the "observed number of connections /expected number of connections" ratios and ran chi-square test for nine pairs of generations in each CoP.

The RCT analysis results shown in Table 3 indicates that p-values are low enough to reject the null hypothesis and conclude that there was a significant difference between the expected and observed numbers of KSCs between pairs of generations. In other words, KS Network Connections in all CoPs were all significantly affected by Generational attributes of their members.

Table 3: RCT analysis results

	CoP1	**CoP2**	**CoP3**
Chi-square value	171.336	90.928	141.2580
P-value	0.007	0.029	0.004

However, it seems the importance of generation is not well perceived by workforces. In the survey, employees were asked about how generational differences can make it difficult to maintain a KSC. Interestingly, the results show at least 70% of members in each CoP believed that the attribute of generation does not matter. The difference between reality and members' perception about the role of generation is a topic which requires more research.

Knowledge Sharing Methods Used Within Knowledge Sharing Connections

The second research question was to determine the methods employees actually used within their existing KSCs to (a) provide and (b) receive knowledge. For each KSC, respondents selected the method in which they provide and receive knowledge based upon the available methods within the CoP. As a result, respondents selected from the following options across all communities: personal discussion (PD), email, meeting, report, instant messaging (IM). In addition, intranet was an option in CoP1, and community forum (forum) was an option in CoPs 2 and 3. The managers of the participating CoPs provided the list of available methods. We analyzed the KSCs according to generational attributes of egos and alters. The relative frequencies of methods used within inter- and intra-generational KSCs are shown in Appendix2.

As shown in Appendix 2 (Tables 26 and 27), a low number of GenYs participated the survey (20 Gen Ys) in CoP3, resulting in a low number of Gen Y-boomer and Gen Y-Gen X KSCs. Moreover, there was no intra-generational KSC for Gen-Ys in that CoP; none of the 20 Gen Ys that participated the survey shared their knowledge with other Gen Ys in CoP3.

We then identified the methods that had a relative frequency of use of at least 10% within the KSCs in at least 2 of the 3 CoPs studied (Table 4). This approach can help to identify the methods that employees used frequently within intra- and inter-generational KSCs.

Table 4: KS methods used within at least 10% of intra- and inter-generational connections in at least two of the three CoPs

Knowledge Receiving Networks			
Ego/Alter	**Boomer**	**Gen X**	**Gen Y**
Boomer	PD- Email	PD- Email- Meeting	PD- Email- Meeting
Gen X	PD- Email- Meeting	PD- Email- Meeting	PD- Email- Meeting
Gen Y	PD- Email	PD- Email- Meeting	PD- Email- IM
Knowledge Giving Networks			
Ego/Alter	**Boomer**	**Gen X**	**Gen Y**
Boomer	PD- Email	PD- Email- Meeting	PD- Email
Gen X	PD- Email- Meeting	PD- Email- Meeting	PD- Email- Meeting
Gen Y	PD- Email- Meeting	PD- Email	PD- Email

The results – shown in Table 4 and Appendix 2 – indicate that PD and email were used frequently within all inter- and intra-generational connections for either providing or receiving knowledge; they formed at least 65% of the methods used within KSC in each network. Meetings were also used frequently in most networks, especially by Gen Xs to provide and receive knowledge with others. Interestingly, IM was used more frequently by Gen Ys within CoPs 1 and 2, where they used IM within 24% of their intra-generational knowledge receiving connections in both CoPs. This amount decreases to 0% and 19%, respectively, in CoPs 1 and 2 when IM is used for giving knowledge between Gen Ys. However, with the exception of some IM use by Boomers to share knowledge with Gen Xs (Boomer-Gen Xs connection), this method was not used in any other intra- or inter-generational KS connections in CoP3. We assumed that the direction of KSCs may affect the methods that were used within intra- and inter-generational connections. Therefore, we analyzed the methods as knowledge receiving method and knowledge providing method separately. Results show, that with the exception of GenYs-

GenYs connections in the knowledge-receiving network, the methods frequently used to receive knowledge are almost the same as the methods used to provide knowledge.

Differences between Generations in Their Use of Different KS Methods

The next question is if there are statistical differences between generations in their use of KS methods. To answer the research question, we first needed to determine whether a relationship existed between the generational attributes of employees and the methods that they use to share their knowledge. To do this, we constructed a crosstab, or contingency, table based on the generational attributes of participants and the methods which they used to exchange knowledge within their connections. Each cell in the table shows the joint frequencies for the variables, in this case, the generational attribute of each participant and the KS method used within their connections. We created six contingency tables, representing the knowledge providing and knowledge receiving information for each of the three CoPs. An example of contingency table provided in Table 5 for CoP1. In this example, the total number of 649 represents the total number of KSCs mentioned by 120 participants in the CoP.

Table 5: Frequency of the most frequent KS methods used by different generations to provide knowledge in CoP1

		KS Methods						
		Report	**Meeting**	**Intranet**	**Email**	**PD**	**IM**	**Total**
Generation	**Boomers**	4	26	0	36	53	7	126
	Gen Xs	13	81	3	136	165	22	420
	Gen Ys	0	10	2	34	45	12	103
	Total	17	117	5	206	263	41	649

Based upon these contingency tables, we tested the following null and alternative hypotheses:

H_0: There is no significant relationship (association) between "generational attributes of employees" and "the methods they use to share their knowledge"

H_1: There is a significant relationship between "generational attributes of employees" and "the methods they use to share their knowledge"

We used MVPstats to run the chi-square test on contingency tables, with the results shown in Table 6. Because the chi-square test should not be conducted if the expected value of any category is less than five, we removed any categories that did not have a value of five or greater. As a result, in this case, intranet was removed as that method had the expected value less than five, and then chi-square test was run. A p-value of 0.006 indicates that there was a relationship between generation and the KS methods used in the networks. The results show, with the exception of the knowledge receiving network in CoP3, there was a strong relationship ($p<0.1$) between generational attributes of employees and the KS methods that were used in the knowledge sharing networks (Table 6).

Table 6: Results of running chi-square test on contingency tables

	CoP 1	**CoP 2**	**CoP 3**
Knowledge Receiving Network	P-value= 0.006 H_0 is rejected. Intranet was removed.	P-value= 0.082 H_0 is rejected. Report, IM, and community forum were removed.	P-value= 0.164 H_0 is accepted. Report, meeting, IM and community forum were removed.
Knowledge Providing Network	P-value= 0.084 H_0 is rejected. Report and intranet were removed.	P-value= 0.091 H_0 is rejected. Report, IM, and community forum were removed.	P-value= 0.05 H_0 is rejected. Report, meeting, IM and community forum were removed.

When a relationship between generation and methods used was identified (indicated by a p-value of less than 0.1), we analyzed the results further for whether generational differences existed in their use of different KS methods e.g whether Gen Xs use email significantly more than Gen Ys. The null and alternate hypotheses were:

H_0: There is no significant difference between generations -Boomers, Gen Xs and Gen Ys - in their use of a KS method

H_1: There is a significant difference between generations in their use of a KS method

We ran the chi-square test using MVPstats to identify KS methods that were different based upon generational attributes. The results are shown in Table 7. In that table, ID indicates that there were insufficient data to make an adequate statistical decision for using a KS method as some expected values were less than five. Cells with bold numbers highlight the cases where the p-value was small enough to reject H_0, and indicate that there was a significant difference between generations in using that KS method; however, we did not know which two generations were different. In these cases, we needed to conduct post-hoc analysis in order to find differences between each pair of generations in their use of the KS method. Other cells show the cases in which the achieved p-value was large enough to accept H_0, and conclude that there was no significant difference between generations in their use of the indicated KS method. For instance, p-value=0.804 in CoP1 indicates that there was not a significant difference between Boomers, Gen Xs, and Gen Ys in using report as a knowledge receiving method in CoP1. Furthermore, because there was not a strong relationship between generation and methods in CoP 3's knowledge receiving network, this network was omitted from further analysis.

Table 7: Results of initial tests

		Initial Test		
		Boomers vs. Gen Xs vs. Gen Ys		
		CoP1	**CoP2**	**CoP3**
Receiving Methods	**Report**	0.804	ID	
	Meeting	0.169	**0.012**	
	Intranet/Forum	ID	ID	
	Email	0.755	0.986	
	Personal discussion	0.575	0.666	
	Instant messaging	**0.000**	ID	
Providing Methods	**Report**	ID	ID	ID
	Meeting	**0.000**	**0.023**	ID
	Intranet/Forum	ID	ID	ID
	Email	0.691	0.508	0.204
	Personal discussion	0.664	0.587	0.452
	Instant messaging	**0.052**	ID	ID

Results show that there was no difference between generations – Boomers, Gen Xs, and Gen Ys – in using PD and email (Table 7). However, differences existed between these generations in their use of meeting and IM. Moreover there was insufficient data to make adequate statistical decision for using report and intranet.

Post-hoc Analysis

A post-hoc analysis was only run for cases when there was a statistical difference between generations in their use of a KS method in order to determine differences between each pair of generations. For this purpose, we ran three pair-wise, two-sample CoP proportion tests on each of the pairs for each designated group of three. The null and alternate hypotheses then tested were:

$H_0: \pi_{Boomer} = \pi_{Gen\ X}$ $H_0: \pi_{Boomer} = \pi_{GenY}$ $H_0: \pi_{GenX} = \pi_{GenY}$

$H_1: \pi_{Boomer} \neq \pi_{GenX}$ $H_1: \pi_{Boomer} \neq \pi_{GenY}$ $H_1: \pi_{GenX} \neq \pi_{GenY}$

Where π = the ratio of the relevant KS method to all KS methods mentioned by each generation. For example, in order to test for differences among generations in their use of PD as a KS method, the π_{Boomer} was defined as:

π_{Boomer} = (the amount of PD mentioned by Boomers) / (the amount of all KS methods mentioned by Boomer).

Any pair-wise proportion tests conducted after running the overall chi-square on multiple groups should be done with a modified α for each comparison where per comparison α is equal to 0.10/c where "c" is the number of comparisons. Because there were three generations, only three pair-wise comparisons could be done, so each was done at the level of α = .033. H_0 was rejected if p-value <=0.033 and it was inferred that there was significant difference between those two generations in using the KS method. Summary of initial and post-hoc analyses is shown in the Table 8.

Table 8: Summary results of initial and post-hoc analyses

	Knowledge Receiving Network			**Knowledge Providing Network**		
	CoP1	**CoP2**	**CoP3**	**CoP1**	**CoP2**	**CoP3**
Report	ND	ID	ID	ID	ID	ID
Meeting	ND	$\pi_B = \pi_{Gx}$ $\pi_B = \pi_{Gy}$ $\pi_{Gx} > \pi_{Gy}$	ID	$\pi_B = \pi_{Gx}$ $\pi_B > \pi_{Gy}$ $\pi_{Gx} > \pi_{Gy}$	$\pi_{Gx} > \pi_B$ $\pi_B = \pi_{Gy}$ $\pi_{Gx} > \pi_{Gy}$	ID
Intranet/ Forum	ID	ID	ID	ID	ID	ID
Email	ND	ND	ID	ND	ND	ND
PD	ND	ND	ID	ND	ND	ND
IM	$\pi_B = \pi_{Gx}$ $\pi_{Gy} > \pi_B$ $\pi_{Gy} > \pi_{Gx}$	ID	ID	$\pi_B = \pi_{Gx}$ $\pi_B = \pi_{Gy}$ $\pi_{Gy} > \pi_{Gx}$	ID	ID

In this table, “ND” means there was no difference among generations in using the KS method, while “ID” means there is insufficient data to make an adequate statistical decision. Please note that the π values are compared in terms of the significant difference, not the absolute difference. For example if $\pi_{Boomer} = \pi_{Gen\ X}$ and $\pi_{Boomer} = \pi_{Gen\ Y}$, this does not necessary mean that $\pi_{Gen\ X} = \pi_{GenY}$.

As mentioned before, no initial analysis was conducted in knowledge receiving network in CoP3. Based on the results shown in Table 8, in all networks with the exception of the knowledge receiving network in CoP3, we found there was no significant difference between generations in using PD and email for providing or receiving knowledge. In fact, PD and email were two KS methods that were used more frequently than other four methods.

Moreover, there was insufficient data in all CoPs to make an adequate statistical decision about intranet and community forum. As the sample size was large, the lack of sufficient data to run the test shows these methods are not among the top used KS methods in these CoPs. This is also true in using report with except of knowledge receiving network in CoP1 where there were enough data to run the tests. Only in that case, there was no difference between generations in using report to receive knowledge.

IM as a knowledge receiving method was used by Gen Ys statistically more than others in CoP1, while there was no significant difference in using this method by Boomers vs Gen Xs. Gen Ys in CoP1 also used IM for providing knowledge significantly more than Gen Xs. However, there is no sufficient data to conduct the make an adequate decision in other two CoPs.

In using meeting as knowledge receiving method, there was no significant difference between generations in CoP1, and there was insufficient data in CoP3 to make an adequate

statistical decision about it. However, results show in CoP2 Gen Xs use meeting significantly more than Gen Ys while there was no significant difference in using meeting by Boomers vs. Gen Xs and Boomers vs. Gen Ys as a knowledge receiving method.

Meeting as a knowledge providing method was used by Boomers and Gen Xs considerably more than Gen Ys in CoP1. In CoP2 Gen Xs used this method statistically more than other two generation in order to give knowledge to the colleagues. And in CoP3, there is not sufficient data to make an adequate statistical decision. As a result, although the rate of using meeting is different between generations, we cannot determine who uses the method more.

Discussion

Throughout our research, we analyzed the influence of generations on knowledge sharing connections (KSCs) between employees in multi-national construction and engineering companies. In addition, we analyzed the methods that different generations used within these connections to provide and receive knowledge. Interestingly, we found that although the attribute of generation affects the distribution of KSCs between employees in all three CoPs studied, generation does not affect the KS methods that employees actually use as much as emphasized by prior studies.

Influence of Generation on Knowledge Sharing Connections

Through the examination of the collected data by RTC analyses, we found that the attribute of generation influenced knowledge exchange patterns in all CoPs. A significant difference was found between the observed frequency (number) of knowledge sharing connections (KSCs) among generations and the expected frequency of KSCs based upon the

given attributes and size of the CoP. We witness this difference within all of the CoPs studied, even though they had different subject area focuses. As a result, we found that generation influences the existence of knowledge sharing connections. Interestingly, despite the significance of generational attributes on the existence of KSCs within the CoP, when we asked CoP members to rate the difficulty of maintaining a KSC with an employee from a different generation, over 70% of respondents in each CoP indicated that generational differences between employees do not make it difficult to maintain a knowledge sharing relationship. This contradiction between employee's beliefs and the statistical results from the analysis of dyadic connections is interesting and deserves further study. Specifically, understanding the reasons why generational differences influence the creation and maintenance of KSCs and the knowledge flow would be a fruitful.

Use of KS Methods by Different Generations

One of the primary aims of this study is to determine how knowledge flows within and between generations by analyzing the used KS methods within inter- and intra- generational KSCs. We found personal discussion (PD) and email were two frequent KS methods that were used in at least 65% of all inter- and intra-generational connections.

We found a significant relationship between generational attributes of employees and the methods they used to receive or give knowledge within KSCs in five knowledge sharing networks. Only one network, the knowledge providing network in CoP3, did not have a significant relationship. Future research should seek to understand why this CoP differs from the others. We then analyzed the differences between generations based upon their use of KS methods for providing and receiving knowledge, i.e. if there is any difference between

Boomers, Gen Xs, and Gen Ys in using email as a knowledge receiving method. Based upon relative frequency of use, PD and email were the most frequently used methods across any generation. The statistical analysis found that there were no differences between generations and their use of these two most frequently used methods for any of the CoPs studied. This part of finding is in contradiction of many prior studies' findings where they focused on identifying different KS methods for different generations. Due to the frequency of the use and the lack of differences between generations, managers should continue to make these knowledge sharing methods widely available within the CoPs. The use of meeting and IM was less frequent across employees of the CoPs. As a result, the statistical analysis did not have sufficient data to complete an analysis for all knowledge sharing networks. When data existed to analyze the use of meetings in KSCs based upon generations, we found that, when differences existed, Boomers tended to use meeting more than Gen Ys and that Gen Xs used meeting more than Gen Ys or Boomers if a difference existed.

When sufficient data existed to analyze the use of IM, the generations had significant differences. The result confirmed the literature by finding that IM was used by younger employees significantly more than elders. Moreover, the lack of adequate data to test these methods statistically indicates that IM was not a popular KS method for all generations, and is mostly used by Gen Ys. With Gen Y's rapidly entering organizations, management should consider how to better integrate IM as a KS method into their work practices.

Conclusions

Prior studies have highlighted the characteristics and learning preferences of each generation in the workplace, and offered general suggestions on how management can facilitate knowledge transfer in organizations by considering the generational attributes of employees. Applying these strategies can help to reduce some of the unexpected problems that arise from generational differences. However, these strategies are generic for all types of organizations and a lack of data exists on how knowledge flows within CoPs in construction companies. In addition, there is a lack of empirical studies on spanning generational boundaries within CoP level in construction field regarding knowledge sharing methods and generations. Specifically, there is a lack of evidence regarding whether generational attributes influence the distribution of knowledge sharing connections and whether differences exist based upon generational attributes for the methods used to provide and receive knowledge within their KSCs. This study is the first known study focusing on knowledge sharing between generations across CoPs active in construction and engineering companies.

To address these needs, this research analyzed data from 734 employees across three multinational Communities of Practice (CoPs) in two construction and engineering companies. We found that generational attributes of employees impact knowledge sharing connections, and thus, knowledge exchange patterns in multi-national construction and engineering companies. Given the dearth of empirical studies focused on spanning generational boundaries this finding is significant as it indicates that more research should be done to determine why generation has such a profound effect.

In addition, we found that there was a relationship between generational attributes of employees and the KS Methods that they use to provide or receive knowledge. The most frequently used methods, personal discussion and email, were used equally by different generations and should continue to be made accessible to employees within CoPs to foster knowledge exchange.

Insufficient data existed across all CoPs to analyze the relationship between generations and use of meeting and IM, however, the data that was able to be analyzed showed a general trend and preference by younger employees to use IM. With a changing workforce that includes the necessity of hiring additional Gen Ys into the workforce, management should consider expanding their KS methods to include IM. Similarly, when data was available for analysis, Generation X employees used meeting more frequently. Furthermore, there was insufficient data to determine differences in generations and their use of report, intranet and community forum and additional research is needed to test statistical differences. However, by considering the large sample size of this study, the lack of sufficient data to run the test indicates that these methods are not the most frequently used methods by employees.

CHAPTER 3: PREFERRED KNOWLEDGE PROVIDING AND RECEIVING METHODS

Employees may be limited in the knowledge sharing methods that they can use within their company. Specifically, they may prefer to use methods that are not available within the organization. In order to determine if employees preferred methods that organizations were not offering, we prepared a comprehensive list of formal, semi-formal and informal KS methods found in the literature, and asked participants to select their top preferred methods from the list. The methods were personal discussion- face to face (PD-face to face), personal discussion-email (PD-email), workshop, meeting, collaborative web space, personal discussion- phone (PD-phone), hardcopies, intranet, instead messaging (IM), blog, podcast, video, and social interface software.

Analyzing the data collected enabled the analysis of the questions: 'What methods do employees prefer to use to share knowledge in multi-national construction companies?', and 'Do differences exist between generations in their preferred KS methods?'. These questions are motivated by the same literature and the analysis of these questions follows research question 2and 3, respectively, which was covered in Chapter 2, and is described in detail in Chapter 4. In order to reduce repetition, we only mention the results of question 4 and 5 in this chapter.

Preferred Knowledge Sharing Methods by Generations

The forth research question was to determine the methods employees preferred to use in order to (a) provide and (b) receive knowledge in organization regardless of who they have contact with. The same analysis used in second research question was conducted here. The only difference is that, whereas six options existed to share knowledge within the CoPs, there

were thirteen options listed for survey participants to select their preferred methods (regardless of if the method existed within organizations) to share their knowledge.

Frequencies of preferred methods are found in Appendix 3. We then identified the methods that had a relative frequency of preferring to use of at least 10% within the KSCs in at least 2 of the 3 CoPs studied (Table 9). This approach can help to identify the methods that employees preferred to use frequently. We analyzed methods as knowledge receiving methods and knowledge providing methods separately to find if the direction of connections affects the methods preferred within knowledge receiving networks and knowledge providing networks (Table 9).

Table 9: KS methods preferred to use within at least 10% of KSCs in at least two of the three CoPs studied

Generations	Knowledge Receiving Networks	Knowledge Providing Networks
Boomers	Face to face	Face to face
	Email	Email
	Workshop	Workshop
	Intranet	Intranet
	Hardcopy	Phone
Gen Xs	Face to face	Face to face
	Email	Email
	Workshop	Workshop
	Intranet	Intranet
Gen Ys	Face to face	Face to face
	Email	Email
	Workshop	-
	Hardcopy	-

The results – shown in Table 9 and Appendix 3 – indicate that face to face discussion and email were preferred frequently within all KSCs for either providing or receiving knowledge in

all CoPs studied. Except of hardcopy and phone, there was no difference between knowledge receiving methods and knowledge providing methods preferred by Boomers. Although the direction of KSCs did not affect the methods preferred by Gen Xs, it resulted in some differences between receiving methods and providing methods preferred by Gen Ys. Findings show workshops were frequently indicated as a preferred method; however, these were not available within the CoPs, at least among the list of available KS methods indicated by company managers. Interestingly, intranet was among the top preferred methods in many networks while the use of this method (as indicated in the previous chapter) was infrequent. Future research should seek to understand the reasons of this contrast.

Differences between Generations in Their Preferring to Use Different KS Methods

The last research question was whether a relationship existed between employees based upon their generational attributes and their preferences of KS methods to provide or receive knowledge. The same analysis that was conducted to answer third research question was conducted here. Because the chi-square test should not be conducted if the expected value of any category is less than five, we removed any categories that did not have a value of five or greater. We found a significant relationship between generational attributes of employees and the KS methods that they preferred to use in CoP 2 (Table 10). However, in contrast, CoPs 1 and 3 did not have a significant relationship. As a result, further analysis was not completed for CoPs 1 or 3.

In CoP2, where a relationship between generation and methods preferred to use was identified (indicated by a p-value of less than 0.1), we analyzed the results further for whether

generational differences existed in their preferring different KS methods e.g whether Boomers prefer to use email more than Gen Ys.

Table 10: Results of running chi-square test on contingency tables

	CoP 1	**CoP 2**	**CoP 3**
Receiving Knowledge	P-value= 0.922 H_0 is accepted. Social interface software, video, podcast, blog, IM, hard copies, intranet, PD-phone, collaborative web space, and meeting were removed.	P-value= 0.062 H_0 is rejected. Podcast, social interface software, blog were removed.	P-value= 0.202 H_0 is accepted. Podcast, IM, social software, video, collaborative space, blog, PD-face to face, PD-phone, and meeting were removed.
Providing Knowledge	P-value= 0.922 H_0 is accepted. Social interface software, video, podcast, blog, IM, hard copies, intranet, PD-phone, collaborative web space, workshop and meeting were removed.	P-value= 0.010 H_0 is rejected. Podcast, social interface software, collaborative web space, and video were removed.	P-value= 0.131 H_0 is accepted. Except of PD-Face and email, other methods were removed.

We ran the chi-square test using MVPstats to test the following hypotheses:

H_0: There is no significant difference between generations -Boomers, Gen Xs and Gen Ys - in their use of a KS method

H_1: There is a significant difference between generations in their use of a KS method

These results are shown in Table 11. ID indicates that there was insufficient data to make an adequate statistical decision for preferring to use the KS method as their expected values were less than five. Moreover, the cells with star highlight the cases where the p-value is small enough to reject H_0, and indicate that there was a significant difference between generations in preferring that KS method; however, we do not know which two generations are

different. In these cases, we needed to conduct the post-hoc analysis in order to find differences between each pair of generations in their use of the KS method.

Table 11: Results of initial tests in CoP2

	Initial Analysis in CoP2	
	Boomers vs. Gen Xs vs. Gen Ys	
	Receiving Network	**Providing Network**
PD-Face to face	0.759	0.816
PD-Email	0.483	0.420
Workshops	0.031*	0.112
Meeting	0.062*	0.826
Web space	0.942	0.093*
PD-Phone	0.110	0.021*
Hard copies	0.650	0.285
Intranet	0.166	0.221
Instant messaging	0.331	0.008*
Blog	ID	ID
Podcast	ID	ID
Video	0.072*	ID
Social interface software	ID	ID

Post-hoc Analysis

A post-hoc analysis was run only for cases with generational differences in preferring a KS method in order to determine differences between each pair of generations. The null and alternate hypotheses then tested were:

$H_0: \pi_{Boomer} = \pi_{Gen\ X}$ $H_0: \pi_{Boomer} = \pi_{GenY}$ $H_0: \pi_{GenX} = \pi_{GenY}$

$H_1: \pi_{Boomer} \neq \pi_{GenX}$ $H_1: \pi_{Boomer} \neq \pi_{GenY}$ $H_1: \pi_{GenX} \neq \pi_{GenY}$

Where π = the ratio of the relevant KS method to all KS methods mentioned by each generation. For example, in order to test for differences among generations in their use of email as a KS method, the π_{Boomer} was defined as:

π_{Boomer} = (the amount of email mentioned by Boomers) / (the amount of all KS methods mentioned by Boomer).

The results of initial and post-hoc analyses in CoP2 show in Table 12.

Table 12: Summary results of initial and post-hoc analyses in CoP2

KS Methods	Knowledge Receiving Network	Knowledge Providing Network
PD- face to face	ND	ND
PD- Email	ND	ND
Workshop	$\pi_{Boomer} = \pi_{GenX}$ $\pi_{Boomer} > \pi_{GenY}$ $\pi_{GenX} = \pi_{GenY}$	ND
Meeting	ARN	ND
Collaborative web space	ND	ARN
PD- Phone	ND	$\pi_{Boomer} = \pi_{GenX}$ $\pi_{Boomer} > \pi_{GenY}$ $\pi_{GenX} = \pi_{GenY}$
Hard copies	ND	ND
Intranet	ND	ND
IM	ND	$\pi_{Boomer} = \pi_{GenX}$ $\pi_{Boomer} < \pi_{GenY}$ $\pi_{GenX} = \pi_{GenY}$
Blog	ID	ID
Podcast	ID	ID
Video	ARN	ID
Social interface software	ID	ID

When a significant difference is found in the initial analysis (the bolded cells in Table 11), we expect to observe a difference between generations in at least one pair-wise comparison in post-hoc analysis. However, in the cases shown as ARN in Table 12, no significant difference was found between generations in the post-hoc analysis although the initial analysis revealed p values under 0.1 for these methods. ARN stands for “additional research is needed" as, there were no statistically reliable differences in the pair-wise comparisons. As a result, the differences require additional research to demonstrate statistical significance. Table 12 also indicates “ND” when there was no difference between generations in their preferred methods to receive or provide knowledge.

The findings show there is no difference between generations in preferring to use PD-face to face, PD- email, hardcopies, and intranet as KS methods. Also they are not different between generations in preferring to use workshop and meeting as knowledge providing method, and collaborative web space, PD- phone and IM as knowledge receiving method. However, a significant difference was found in preferring workshop as a knowledge receiving method and PD- phone as a knowledge providing method since Boomers prefer to use them significantly more than Gen Ys. Moreover, Gen Ys prefer to use IM to provide knowledge significantly more than Boomers. For other KS methods, no difference was found between generations in preferring them.

Discussion

Knowledge Sharing Methods Preferred to Use by Generations

To determine the KS methods that were highly preferred by each generation, we asked survey participants to selected their preferred methods to provide or receive knowledge from

thirteen options. The same analysis as that used in second research question was conducted here. Based upon relative frequency of preferring to use, we found face to face discussion, email, and workshop are highly preferred by employees regardless of their generations. In each CoP, these three methods were formed at least 43% of KS methods preferred by each generation. Interestingly we found intranet was among the highly preferred methods for many employees, while in reality employees did not use it frequently. Future research should seek to understand the reasons of this contrast.

Differences between Generations in Their Preferring to Use Different KS Methods

We found there is a significant relationship between generational attributes of employees and the KS methods that they preferred to use in CoP 2, but not in CoPs 1 and 3. We then analyzed the differences between generations based upon their preferring to use of KS methods for providing and receiving knowledge in CoP 2, i.e. if there was any difference between Boomers, Gen Xs, and Gen Ys in preferring to use meeting as a knowledge receiving method. Findings show there was no difference between generations in preferring to use PD-face to face, PD- email, hardcopies, and intranet as KS methods, workshop and meeting as knowledge providing method, and collaborative web space, PD- phone and IM as knowledge receiving method. This part of finding is in contradiction of some prior studies' findings where the studies show olders' preferred learning styles involve hard copies of text and formal process while younger people prefer informal learning and methods.

We also found Boomers prefer to use workshop as a knowledge receiving method and phone as a knowledge providing method significantly more than Gen-Ys. Moreover, Gen Ys prefer to use IM as a knowledge providing method significantly more than Boomers. This part

of findings match with the prior studies' findings as they found older people highly value face-to-face conversations to transfer knowledge while younger people use informal KS methods such as IM more than older ones.

Conclusion

We analyzed the data gathered from three CoPs across two construction and engineering companies to find the most frequent KS methods that different generations prefer to use regardless of with who they would share their knowledge. We also answered the question of if there was any difference between generations in their preferring to use KS methods. Findings show some generational differences in preferring to use workshop as knowledge receiving method and IM and phone as knowledge providing ones. It is suggested to add workshop to available KS methods as it was not available within the CoPs, at least among the list of available KS methods indicated by company managers. Moreover, only in one out of three participated CoPs, there was a relationship (association) between generational attributes of employees and the KS methods that generations preferred to use. Future research should seek to understand the reasons of this difference between the CoPs. Future studies should also search to understand the reasons of why intranet was a highly preferred method for generations, while they did not actually use it frequently.

CHAPTER 4: DETAILED RESEARCH METHODS

As mentioned, Chapter 2 is a complete journal paper that addresses the first three questions, and Chapter 3 addresses the fourth and fifth research questions and their answers. Due to the space limitations in journal paper, the methodology and analysis of all research questions posed above are described in more detail in this Chapter.

To begin, the research team sent a questionnaire to the members of three communities of practice (CoP) across two multinational construction and engineering companies. The survey included questions regarding the share-point CoP, background information of the employees (used as attributes), and network questions. For this research, we analyzed the questionnaire to determine (1) whether the employees' generation mattered for knowledge sharing, (2) the most frequent methods used to exchange knowledge, and (3) the most preferred methods for sharing knowledge among CoP members.

We administered the survey through Network Genie software. Network Genie is a web-based, social-network survey-data collection. It helps researchers to design social network questions, collect data, and export the data for social network analysis[2]. The software allows the administration of both ego-centric and complete networks; however, we administered complete networks. As a result, survey participants can select other CoP members with whom they have a knowledge sharing connection from a complete list of CoP members rather than manually entering the CoP members with whom they exchange knowledge.

[2] For more information, please visit https://secure.networkgenie.com/

The data was analyzed using UCINET and Netminer software. UCINET is a software package using for the analysis of social network data. We used the software for answering the first research question where a powerful statistical tool was needed. For other research questions where working with different attributes of actors and building several block models were required, we used Netminer software. In fact, Netminer is a tool that helps researchers in exploratory analysis and visualization of network data. The software enables researchers to categorize people's attributes (node attributes)—such as generational or geographical location —, visualize and analyze the data based upon these attributes. We analyzed the data from Netminer using several statistical tests, which included chi-square and proportion tests to determine whether differences found between generations in using or preferring to use some KS methods were statistically important.

Influence of Generation on Knowledge Sharing Connections

The first research question is whether generation matters for knowledge exchange patterns in multi-national construction and engineering companies. To answer this question, we analyzed the connections within and between groups of employees when they were categorized based on their generational attributes, and applied Relational Contingency Table (RCT) analysis to determine if there was an association between the generational attributes of employees and the likelihood of a knowledge sharing connection between two employees. In fact, RCT analysis helped us to determine whether the observed network connections are affected by the attribute of generation, or connections were randomly distributed across all generations. RCT represents the amount of connections present or absent between pairs of

generations. Figure 2 shows an example of RCT analysis based on generational attributes in CoP2 using UCINET. The figure of RTC shows the frequency of each generation, and the total number, the observed number ("Cross-classified frequencies), and expected number of KSCs in the CoP. Here Boomers, Gen Ys, Gen Xs and Veterans were labeled as 1, 2, 3 and 4, respectively.

In the survey, we asked employees with whom they had exchanged knowledge on job-related CoP practices in the past six months. Answers to this question when generational attributes of employees were considered provided the observed frequency of connections within and between generations. However, the expected frequency of connections is that predicted by chance alone of a network of equal size and same attributes when there is no association between sharing the same attribute, i.e. being in the same generation and the likelihood of a connection between two employees. The expected numbers shown in Figure 2 were performed under the model of independency by 10000 random iterations for the same numbers of generations in CoP2 including four Veterans, 133 Boomers, 228 Gen Xs, and 101 Gen Ys.

Applied to our three generations, the RCT analysis calculated the ratios of “observed/expected” for nine pairs of generations in each CoP, i.e. including three comparisons within generations and six between generations. Any "Observed/Expected" unequal to one showed difference between observed and expected numbers. In order to identify whether the difference is statistically significant, RCT applies chi-square to test the following hypotheses:

H_0: expected numbers of connections between pairs of generations = observed numbers of connections between pairs of generations

H_1: expected numbers of connections between pairs of generations ≠ observed numbers of connections between pairs of generations

```
  Old Code     New Code    Frequency
  ========     ========    =========
      1     =>     1          133
      2     =>     2          101
      3     =>     3          228
      4     =>     4            4
Number of ties: 557.000
Cross-classified Frequencies
              1   2   3   4
              1   2   3   4
            --- --- --- ---
    1   1   85  17 111   1
    2   2   16  17  43   0
    3   3   81  37 146   0
    4   4    2   0   1   0

Expected Values Under Model of Independence
                 1      2      3      4
                 1      2      3      4
            ------ ------ ------ ------
    1   1   45.13  34.53  77.95   1.37
    2   2   34.53  25.96  59.19   1.04
    3   3   77.95  59.19 133.04   2.34
    4   4    1.37   1.04   2.34   0.03

Observed/Expected
               1    2    3    4
               1    2    3    4
            ---- ---- ---- ----
    1   1  1.88 0.49 1.42 0.73
    2   2  0.46 0.65 0.73 0.00
    3   3  1.04 0.63 1.10 0.00
    4   4  1.46 0.00 0.43 0.00

Average permutation frequency table
                1      2      3      4
           ------ ------ ------ ------
    1     45.19  34.57  78.15   1.35
    2     34.50  25.69  58.99   1.03
    3     78.04  59.09 133.35   2.32
    4      1.35   1.02   2.33   0.03
Observed chisquare value = 90.928
Significance = 0.029697
Number of iterations = 10000
```

Figure 2: RCT analysis for generational boundaries in CoP2

The p-values achieved from RCT analysis are low enough to reject the null hypothesis in all communities (Table 13), and infer that there was a significant difference between expected

and observed numbers of KSCs between pairs of generations in all three CoPs .In other words, network connections in all CoPs were affected by their employees' attribute of generation.

Table 13: RCT analysis results

	CoP1	CoP2	CoP3
Chi-square value	171.3360	90.9280	141.2580
P-value	0.0070	0.0297	0.0044

Knowledge Sharing Methods Used Within Knowledge Sharing Connections

Analyses and results of the second research question were well described in Chapter 2.

Differences between Generations in Their Use of Different KS Methods

The third research question is if there is any significant difference between generations in using different KS methods. For each KSC, respondents selected the method in which they provide and receive knowledge based upon the available methods within the CoP. As a result, respondents selected from the following options across all communities: personal discussion (PD), email, meeting, reports, instant messaging (IM). In addition, intranet was an option in CoP1, and community forum (forum) was an option in CoPs 2 and 3.

To answer this research question, we first needed to determine whether a relationship existed between generational attributes of employees and the methods that they use (and prefer to use) to share knowledge. We focused on the methods that CoP members reported using to exchange knowledge within each KSC. To do this, we built a crosstab table based on the generational attributes of participants and the methods which they used within their connections. A crosstab table – also called a contingency table – is a cross-classification of two variables. Each cell in the table shows the joint frequencies for the variables, in this case, the attribute of generation and the KS methods used within their connections. We created six

contingency tables, representing the knowledge providing and knowledge receiving information for each of the three CoPs. An example of contingency table for CoP1 provided in Table 14. In this example, the total number of 649 represents the total number of KSCs mentioned by 120 participants in CoP1.

Table 14: An example of contingency table for knowledge providing network in CoP1

		KS Methods						
		IM	**PD**	**Email**	**Meeting**	**Intranet**	**Report**	**Total**
Generation	**Boomers**	7	53	36	26	0	4	126
	Gen Xs	22	165	136	81	3	13	420
	Gen Ys	12	45	34	10	2	0	103
	Total	41	263	206	117	5	17	649

Based upon these contingency tables, we tested the following null and alternate hypotheses:

H_0: There is no significant relationship (association) between "generational attributes of employees" and "the methods they use to share their knowledge"

H_1: There is significant relationship between "generational attributes of employees" and "the methods they use to share their knowledge"

The chi-square is the appropriate test for association when we are looking at a crosstab table. If the achieved p-value is greater than α, the null hypothesis is accepted and it is inferred that there is no significant relationship between generation and the used KS methods. Required information to build more contingency tables for other knowledge networks can be found in Appendix 2 (Table 25). Table 15 shows the result of the chi-square test - conducted in MVPStats - on the data shown in Table 14. In the table, expected values were indicated in the parentheses. Boomers, Gen Xs, and Gen Ys are shown by Generation=1, Generation=2, and

Generation=3, respectively. Because the chi-square test should not be conducted if the expected value of any category is less than 5, we removed any categories that did not have a value of 5 or greater. As a result, in this example, intranet and report (shown as methods 5 and 6 in MVPstats in Table 15) were removed, and chi-square test was run again. The results are shown in Table 16. For example, the achieved P-value in Table 16 is 0.084, indicating that there was a relationship between generational attribute of employees and the KS methods they used in knowledge providing network in CoP1. This approach was applied for all six networks, and the results are shown in Table 17.

Table 15: Running chi-square test on knowledge providing network in CoP1

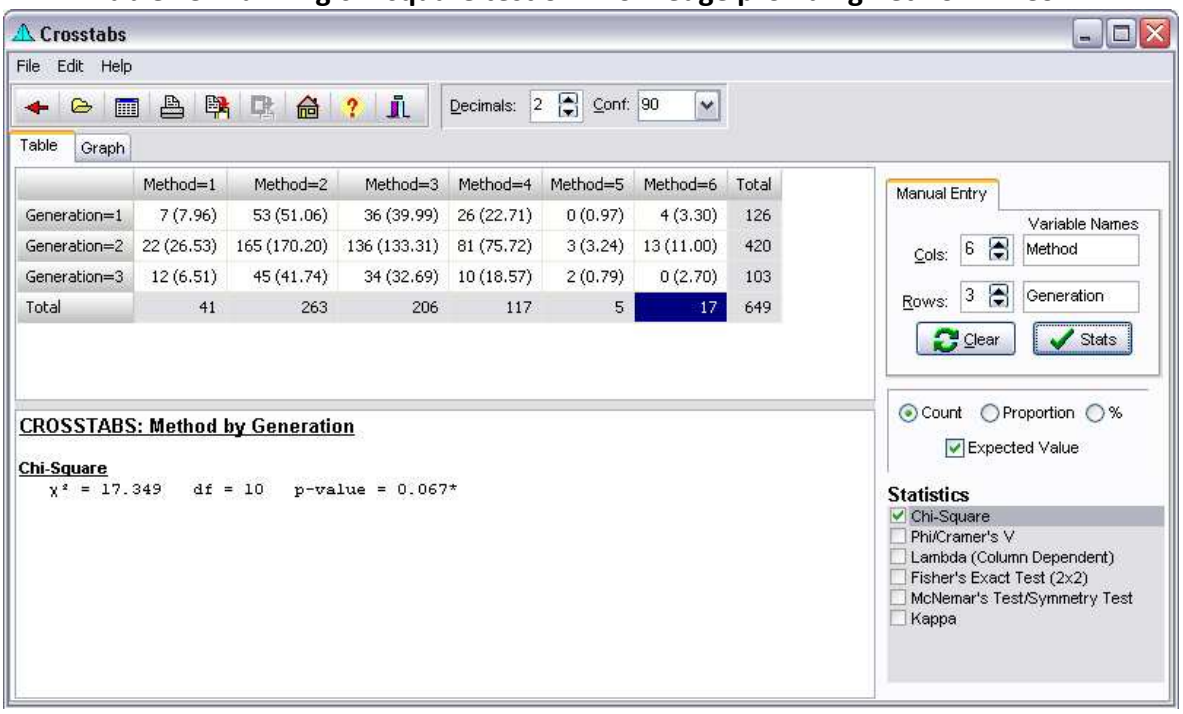
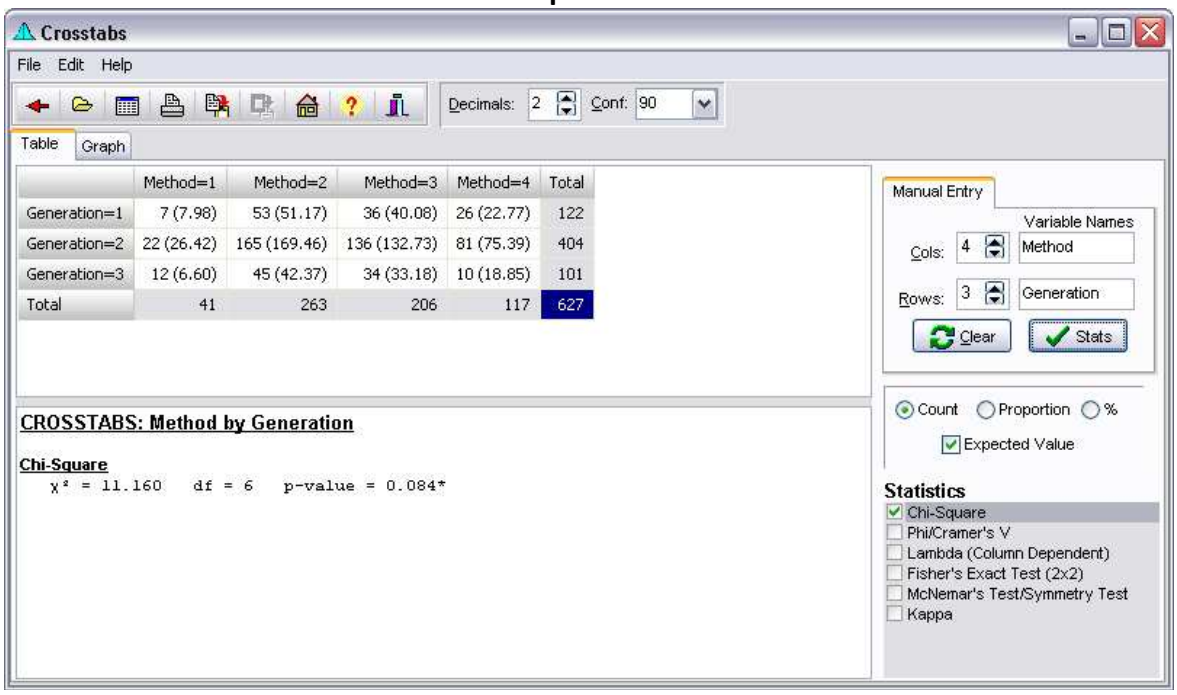


Table 16: Running chi-square test on knowledge providing network in CoP1 after removing the methods with expected value less than five



The results show, with the exception of the knowledge receiving network in CoP3, there was a strong relationship ($p<0.1$) between generational attributes of employees and the KS methods that were used in the knowledge sharing networks (Table 17).

Table 17: Results of running chi-square test on contingency tables

	CoP 1	**CoP 2**	**CoP 3**
Receiving Network	P-value= 0.006 H_0 is rejected Intranet was removed.	P-value= 0.082 H_0 is rejected Report, IM, and community forum were removed.	P-value= 0.164 H_0 is accepted Report, meeting, IM and community forum were removed.
Providing Network	P-value= 0.084 H_0 is rejected Report and intranet were removed.	P-value= 0.091 H_0 is rejected Report, IM, and community forum were removed.	P-value= 0.05 H_0 is rejected Report, meeting, IM and community forum were removed.

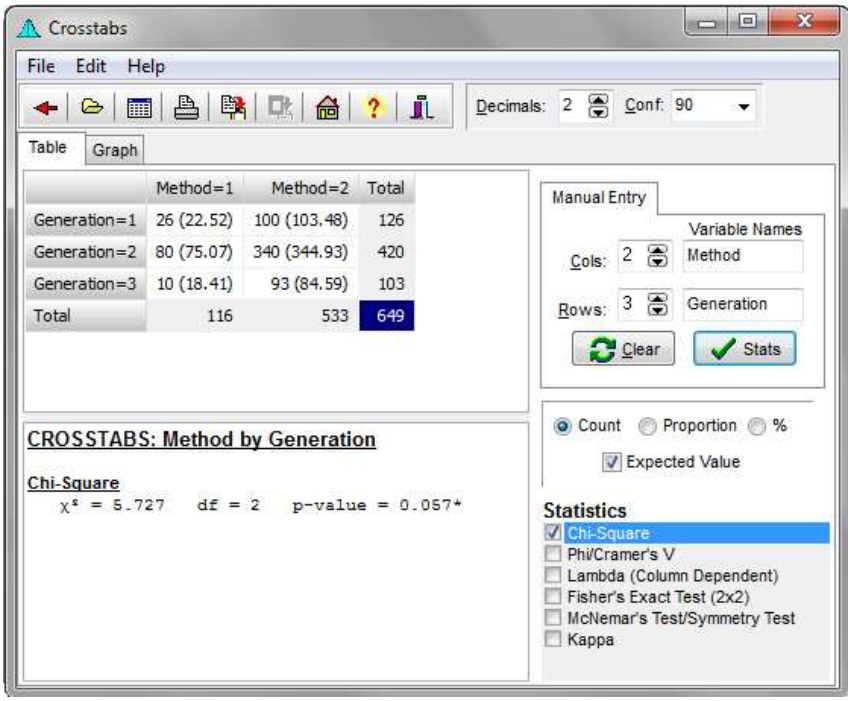
When a relationship between generation and methods used was identified (indicated by a p-value of less than 0.1), we analyzed the results further for whether generational differences existed in their use of different KS methods. The null and alternate hypotheses were:

H_0: There is no significant difference between generations -Boomers, Gen Xs and Gen Ys - in their use of a KS method

H_1: There is a significant difference between generations in their use of a KS method

We ran the chi-square test using MVPstats to identify KS methods that were different based upon generational attributes. As an example, Table 18 shows the result of running chi-square test on the amount of using meeting in CoP1 to find if generational differences existed in their use of meeting as a knowledge providing method.

Table 18: Running chi-square test on the amount of using meeting as a knowledge providing method in CoP1



Also Method=1 stands for meeting used by a generation while Method=2 stands for other five methods which the generation used to provide knowledge in CoP1. For example, the

first line of this table shows that meeting was mentioned 26 times out of 126 KS methods that Boomer used to provide knowledge for their colleagues in CoP1, while other five methods were mentioned 100 times. P-value=0.057 indicates that there was a significant difference between Boomers, Gen Xs, and Gen Ys in using meeting as a knowledge providing method in CoP1. This test was run for six methods used to provide and receive knowledge in all CoPs and the results are shown in Table 19.

Table 19: Results of initial tests

		Initial Test		
		Boomers vs. Gen Xs vs. Gen Ys		
		CoP1	CoP2	CoP3
Receiving Methods	Report	0.804	*ID*	
	Meeting	0.169	**0.012**	
	Intranet/Forum	*ID*	*ID*	
	Email	0.755	0.986	
	Personal discussion	0.575	0.666	
	Instant messaging	**0.000**	*ID*	
Providing Methods	Report	*ID*	*ID*	*ID*
	Meeting	**0.054**	**0.023**	*ID*
	Intranet/Forum	*ID*	*ID*	*ID*
	Email	0.691	0.508	0.204
	Personal discussion	0.664	0.587	0.452
	Instant messaging	**0.052**	*ID*	*ID*

ID indicates that there was insufficient data to make an adequate statistical decision for using the KS method as their expected values were less than five. The cells with bold numbers highlight the cases where the p-value is small enough to reject H_0, and indicate that there was a significant difference between generations in using that KS method; however, in these cases we did not know which two generations are different. As a result, we conducted the post-hoc

analysis in order to find differences between each pair of generations in their use of the KS method. Other cells show the cases in which the achieved p-value is large enough to accept H_0, and conclude that there was no significant difference between generations in their use of the indicated KS method, i.e. P-value=0.804 in CoP1 indicates that there was not a significant difference between Boomers, Gen Xs, and Gen Ys in using report as a knowledge receiving method in CoP1. Because there was not a strong relationship between generation and KS methods in CoP 3's knowledge receiving network, this network was omitted from further analysis.

Post-hoc Analysis

A post-hoc analysis was run only for bold cases, indicating generational differences exist in their use of different KS methods, in order to determine differences between each pair of generations. For this purpose, we ran three pair-wise, two-sample CoP proportion tests on each of the pairs for each designated group of three. The null and alternate hypotheses then tested were:

$H_0: \pi_{Boomer} = \pi_{Gen\ X}$ $H_1: \pi_{Boomer} \neq \pi_{GenX}$

$H_0: \pi_{Boomer} = \pi_{GenY}$ $H_1: \pi_{Boomer} \neq \pi_{GenY}$

$H_0: \pi_{GenX} = \pi_{GenY}$ $H_1: \pi_{GenX} \neq \pi_{GenY}$

Any pair-wise proportion tests conducted after running the overall chi-square on multiple groups should be done with a modified α for each comparison where per comparison α is equal to 0.10/c where "c" is the number of comparisons. Because there were three groups, only three pair-wise comparisons could be done, so each was done at α = .033 level. H_0 was rejected if p-value <= .033 and it was inferred that there was significant difference between

those two generations in using the KS method. Following tables show the results of proportion tests ran in MVPstats on using meeting as a knowledge providing method in CoP1.

Table 20: Running proportion test on the amount of using meeting by Boomers and Gen Ys as a knowledge providing method in CoP1

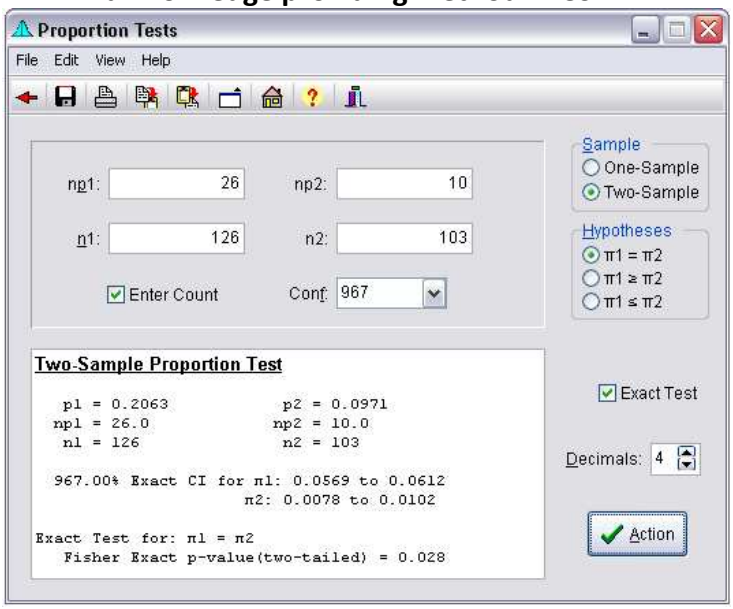


Table 21: Running proportion test on the amount of using meeting by Boomers and Gen Xs as a knowledge providing method in CoP1

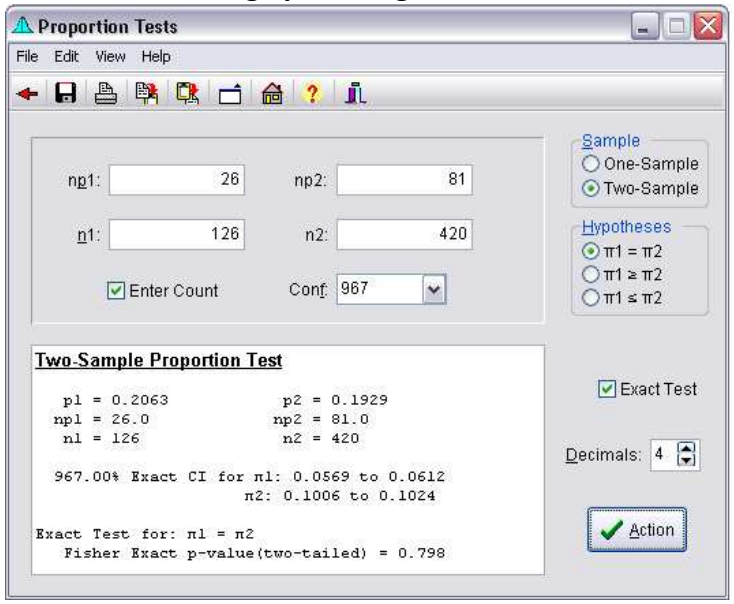
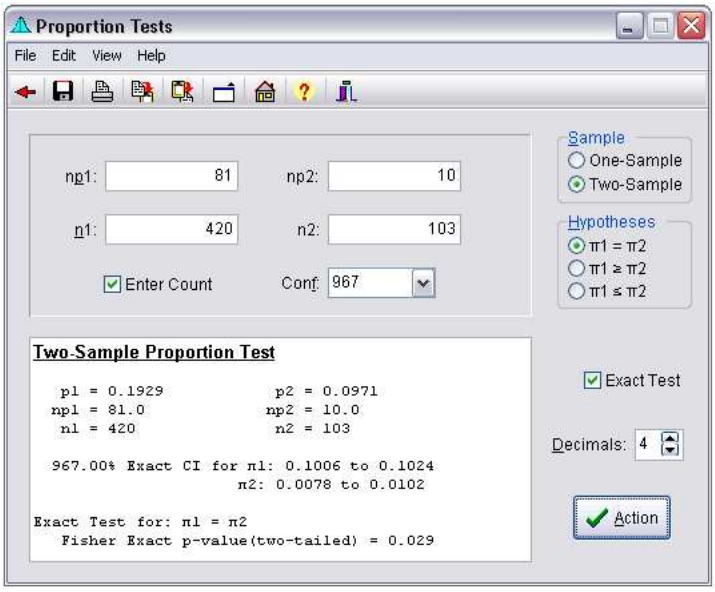


Table 22: Running proportion test on the amount of using meeting by Gen Xs and Gen Ys as a knowledge providing method in CoP1



The following table shows the achieved p-value in the initial and post-hoc analyses.

Table 23: Initial and post-hoc analyses results

		Initial test Boomers vs. Gen Xs vs. Gen Ys			**Post-hoc test: Proportion test** $H_0: \pi_{Boomer} = \pi_{Genx}$ $H_1: \pi_{Boomer} \neq \pi_{Genx}$			$H_0: \pi_{Boomer} = \pi_{Geny}$ $H_1: \pi_{Boomer} \neq \pi_{Geny}$			$H_0: \pi_{Genx} = \pi_{Geny}$ $H_1: \pi_{Genx} \neq \pi_{Geny}$		
		CoP	CoP2	CoP	CoP1			CoP2			CoP3		
		B vs G_X vs G_Y			B vs G_x	B vs G_y	G_x vs Gy	B vs G_x	B vs G_y	G_x vs G_y	B vs G_x	B vs G_y	G_x vs G_y
Receiving Methods	Report	0.80	ID										
	Meeting	0.17	**0.01**					0.1	0.07	**0.00**			
	Intranet /Forum	ID	ID										
	Email	0.76	0.99										
	PD	0.58	0.67										
	IM	**0.000**	ID		0.3	**0.0**	**0.00**						
Providing Methods	Report	ID	ID	ID									
	Meeting	**0.054**	**0.02**	ID	0.7	**0.0**	**0.02**	**0.0**	0.35	**0.02**			
	Intranet/ Forum	ID	ID	ID									
	Email	0.69	0.51	0.20									
	PD	0.66	0.59	0.45									
	IM	**0.052**	ID	ID	0.6	0.16	**0.01**						

As mentioned, knowledge receiving network in CoP3 was omitted from further analysis. The hachured cells in post-hoc analyses show the cases for those in initial analyses we found either no significant difference among proportions of using a KS method by different generations or no sufficient data to make an adequate statistical decision. Cells with bold numbers show the cases with found significant generational differences in their use of KS methods. A summary of findings is shown in Table 24. "ND" means there was no difference among generations in using the KS method, while "ID" means there is insufficient data to make an adequate statistical decision. Findings show no generational differences exist in using PD and Email in the five CoPs studied. However, as shown below and well-described in Chapter 2, there is a significant difference between generations in using meeting and IM as KS methods.

Table 24: Summary results of initial and post-hoc analyses

	Knowledge Receiving Network			**Knowledge Providing Network**		
	CoP1	**CoP2**	**CoP3**	**CoP1**	**CoP2**	**CoP3**
Report	ND	ID	ID	ID	ID	ID
Meeting	ND	$\pi_B = \pi_{Gx}$ $\pi_B = \pi_{Gy}$ $\pi_{Gx} > \pi_{Gy}$	ID	$\pi_B = \pi_{Gx}$ $\pi_B > \pi_{Gy}$ $\pi_{Gx} > \pi_{Gy}$	$\pi_{Gx} > \pi_B$ $\pi_B = \pi_{Gy}$ $\pi_{Gx} > \pi_{Gy}$	ID
Intranet/ Forum	ID	ID	ID	ID	ID	ID
Email	ND	ND	ID	ND	ND	ND
PD	ND	ND	ID	ND	ND	ND
IM	$\pi_B = \pi_{Gx}$ $\pi_{Gy} > \pi_B$ $\pi_{Gy} > \pi_{Gx}$	ID	ID	$\pi_B = \pi_{Gx}$ $\pi_B = \pi_{Gy}$ $\pi_{Gy} > \pi_{Gx}$	ID	ID

The same analyses were conducted for generations' preferred methods to receive and provide knowledge. The only difference is that, whereas six options, there were thirteen options listed for survey participants to select from regarding their preferred methods. Figure 3

shows a summary of the statistical-analysis process run in the third and fifth research questions.

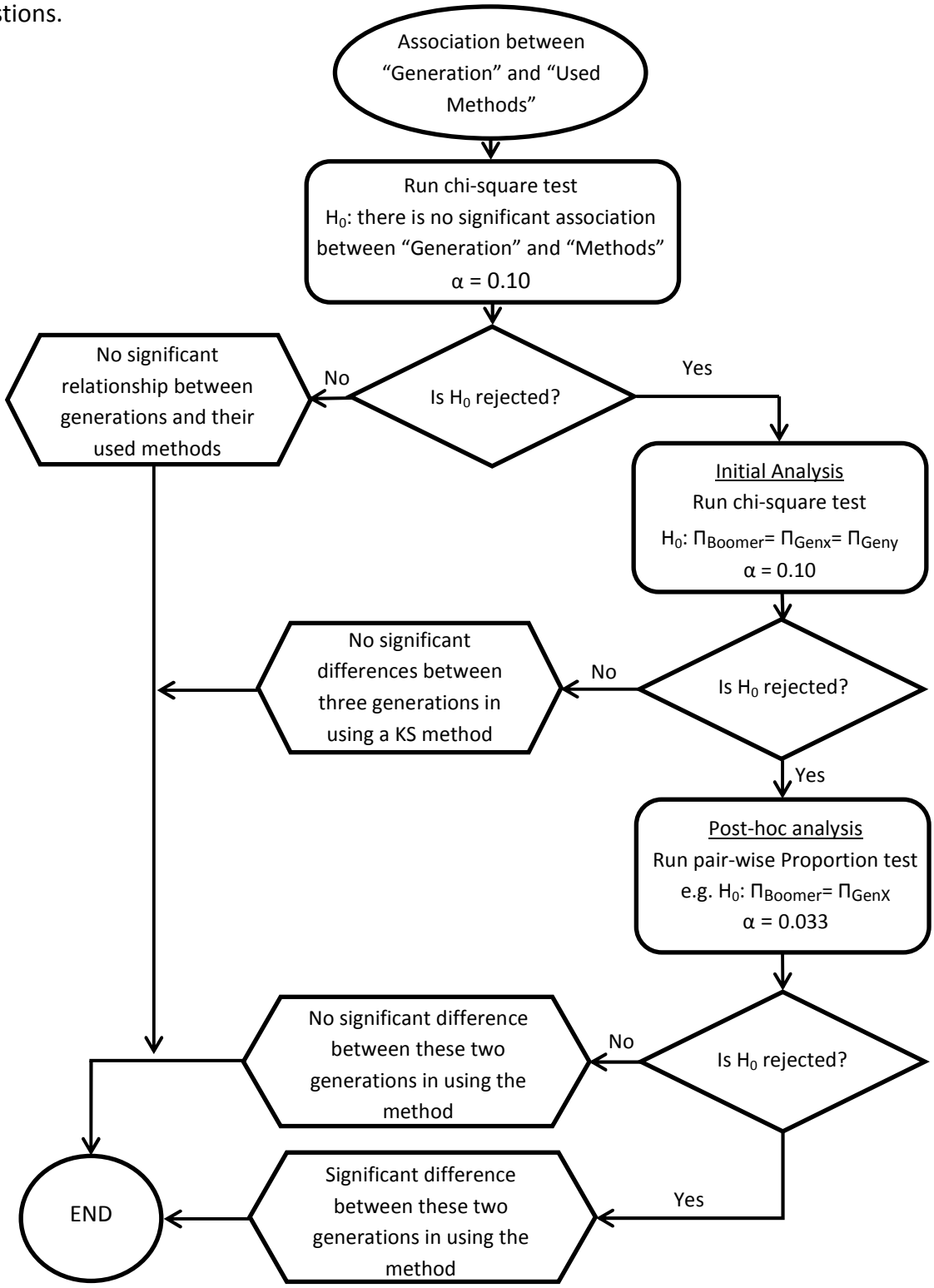


Figure 3: Summary of statistical-analysis process ran for questions 3 and 5

CHAPTER 5: CONCLUSION

Today, construction and engineering industry faces challenges arose from demographic diversity in workplaces as well as losing huge number of experienced employees. To encourage employees to share their knowledge more, management needs to recognize the differences exist between generations, and make diverse knowledge transfer methods available to suit different generational learning styles existing in the workforce. To uncover these differences, this research focused on KS methods used by different generations to provide and receive knowledge within multi-national construction and engineering organizations headquartered in the United States. This study also aims to identify the KS methods highly preferred to use by each generation. The following chapter provides an overview of five research questions results – mentioned in Chapter 2 and 3 – and an overview of the research's theoretical contributions as well as limitations and recommended future research.

1. Influence of Generation on Knowledge Sharing Connections

Through the examination of the collected data by RTC analyses, we found knowledge exchange patterns in all CoPs were significantly affected by generational attributes of their members. We witness this influence within all of the CoPs studied, even though they had different subject area focuses. Interestingly, despite the significance of generational attributes on the existence of KSCs within CoPs, when we asked CoPs members to rate the difficulty of maintaining a KSC with an employee from a different generation, over 70% of respondents in each CoP indicated that generational differences between employees do not make it difficult to maintain a knowledge sharing relationship. This contradiction between employee's beliefs and

the statistical results from the analysis of dyadic connections is interesting and deserves further study. Specifically, understanding the reasons of why generational differences influence the creation and maintenance of KSCs and the knowledge flow would be a fruitful.

2. Knowledge Sharing Methods Used Within Knowledge Sharing Connections

One of the primary aims of this study is to determine how knowledge flows within and between generations by analyzing the used KS methods within inter- and intra- generational KSCs. Findings show no generational differences exist for using PD and email within KSCs, and they were used in at least 65% of all inter- and intra-generational connections in each CoP. Except of CoP3 in which there was no intra-generational connections for Gen Ys, IM formed 24% of all knowledge receiving connections within Gen Ys in both CoPs 1 and 2. Moreover, meetings were used frequently in most networks, especially by Gen Xs to provide and receive knowledge with others.

3. Differences between Generations in Their Use of Different KS Methods

Findings show there was a significant relationship between generational attributes of employees and the KS methods they used within KSCs in five knowledge sharing networks. The exception was knowledge providing network in CoP3 with no significant relationship. Future research should seek to understand why this CoP differs from the others. Moreover, there was no significant difference between generations in using PD and email for providing or receiving knowledge. In fact, PD and email were two KS methods that were used more frequently than other four methods.

The use of meeting and IM was less frequent across employees of the CoPs. As a result, the statistical analysis did not have sufficient data to complete an analysis for all knowledge

sharing networks. When data existed to analyze the use of meetings in KSCs based upon generations, we found that, when differences existed, Boomers tended to use meeting more than Gen Ys and that Gen Xs used meeting more than Gen Ys or Boomers if a difference existed.

When sufficient data existed to analyze the use of IM, the generations had significant differences. The result confirmed the literature by finding that IM was used by younger employees significantly more than elders. Moreover, the lack of adequate data to test these methods statistically indicates that IM was not a popular KS method for all generations, and is mostly used by Gen Ys. With Gen Y's rapidly entering organizations, management should consider how to better integrate IM as a KS method into their work practices.

4. Preferred Knowledge Sharing Methods by Generations

In this study, we also analyzed the data to identify the KS methods that were highly preferred to use by each generation. Based upon relative frequencies, email and face to face discussion are highly preferred by employees regardless of their generations. Workshop was frequently indicated as a preferred method; however, that was not available within the CoPs, at least among the available methods indicated by company managers. Moreover, intranet was among the top preferred methods in many networks, while in reality employees did not use intranet frequently. Future research should seek to understand the reasons of this contrast.

5. Differences between Generations in Their Preferring to Use Different KS Methods

We found there was a significant relationship between employees' attribute of generations and the KS methods that they preferred to use only in CoP 2. We then analyzed the differences between generations based upon their preferring to use a KS method for providing and receiving knowledge in CoP 2, i.e. if there was any difference between Boomers, Gen Xs,

and Gen Ys in preferring to use meeting as a knowledge receiving method. Findings show there was no difference between generations in preferring to use PD- face to face, PD- email, hardcopies, and intranet as KS methods, workshop and meeting as knowledge providing method, and collaborative web space, PD- phone and IM as knowledge receiving method. This part of finding is in contradiction of some prior studies' findings where the studies show older' preferred learning styles involve hard copies of text and formal process while younger people prefer informal learning and methods.

Findings show generational differences exist in preferring to use workshop, phone, and IM; we found Boomers prefer to use workshop as a knowledge receiving method and phone as a knowledge providing method significantly more than Gen-Ys. Moreover, Gen Ys prefer to use IM as a knowledge providing method significantly more than Boomers. Interestingly, this part of findings match with the prior studies' findings as they found older people highly value face-to-face conversations to transfer knowledge while younger people use informal KS methods such as IM more than older ones.

Theoretical Contributions

Findings show interestingly generational attributes of employees impact knowledge exchange patterns in multi-national construction and engineering companies. Given the dearth of empirical studies focused on spanning generational boundaries this finding is significant as it indicates that more research should be done to determine why generation has such a profound effect. Moreover, findings show at least 70% of members in each CoP believed that the

attribute of generation does not matter. The difference between reality and members' perception about the role of generation is a topic which requires more research.

In addition, findings indicate that there was a relationship between generational attributes of employees and the KS methods they use to provide or receive knowledge in five out of six networks studied. However, there was a relationship between employees' attribute of generation and their preferred KS methods in only two out of the six knowledge networks. Future studies should address why this difference exists.

Practical Contributions

The most frequently used methods, personal discussion and email, were used equally by different generations and should continue to be made accessible to employees within CoPs to foster knowledge exchange. Insufficient data existed across all CoPs to analyze the relationship between generations and use of meeting and IM, however, the data that was able to be analyzed showed a general trend and preference by younger employees to use IM. With a changing workforce that includes the necessity of hiring additional Gen Ys into the workforce, management should consider expanding their KS methods to include IM. Similarly, when data was available for analysis, Generation X employees used meeting more frequently. Furthermore, there was insufficient data to determine differences in generations and their use of report, intranet and community forum and additional research is needed to test statistical differences. However, by considering the large sample size of this study, the lack of sufficient data to run the test indicates that these methods are not the most frequently used methods by employees. We found workshop is among highly preferred methods by employees regardless

of their generations. We also found Boomers prefer to use workshop as a knowledge receiving method and phone as a knowledge providing method significantly more than Gen-Ys. It is suggested to add workshop to available KS methods as it was not available within the CoPs, at least among the list of available KS methods indicated by company managers.

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APPENDIX 1: Questionnaire

Note: I only analyzed some questions from those given in the questionnaire and only those questions used in this study are provided in appendix 1.

Person-centered Questions

1) What is your year of birth? (Please type the year).
2) What are your top two preferred methods for receiving knowledge regardless of whether this method is currently available in your organization? (Please select the top two most preferred.)
    a. Hard copies and text driven material (i.e. books, reports, etc.)
    b. Personal discussion- email
    c. Personal discussion- face-to-face
    d. Personal discussion- phone
    e. Workshops
    f. Meetings
    g. Intranet (i.e. Share Point, forums, etc.)
    h. Blog
    i. Podcast
    j. Collaborative web space (i.e. wiki)
    k. Video
    l. Social interface software
    m. Instant messaging

3) What are your top two preferred methods for sharing (giving) your knowledge to others regardless of whether this method is currently available in your organization? (Please select the top two most preferred.)
    a. Hard copies and text driven material (i.e. books, reports, etc.)
    b. Personal discussion- email
    c. Personal discussion- face-to-face
    d. Personal discussion- phone
    e. Workshops
    f. Meetings
    g. Intranet (i.e. Share Point, forums, etc.)
    h. Blog
    i. Podcast
    j. Collaborative web space(i.e. wiki)

k. Video
l. Social interface software
m. Instant messaging

4) Assume that you are trying to communicate knowledge with another CoP employee who is different from you in the following ways (i.e. Works in a different geographic location). Please rate how difficult each of the following factors makes it to maintain a knowledge sharing relationship.
    a. Works in a different GEOGRAPHIC LOCATION
    b. From a different DISCIPLINARY BACKGROUND
    c. Working in a different BUSINESS PRACTICE SPECIALTY
    d. In a different HIERARCHICAL LEVEL WITHIN THE ORGANIZATION
    e. Of a different GENERATION

Network questions

5) Who have you exchanged knowledge with on job related CoP practices in the past 6 months?
6) To assist in determining the flow of information and knowledge within the network, please select the response that best describes your CoP knowledge exchange with each individual listed below.
    a. Only receive
    b. Mostly receive
    c. Receive and Give
    d. Mostly give
    e. Only give
7) Please select the top two most frequent methods used to exchange knowledge with each individual listed below for CoP related work tasks. (Please select top two for each individual.)
    a. Reports
    b. Meetings
    c. Community forum
    d. Email
    e. Personal discussion
    f. Instant Messaging

APPENDIX 2: KNOWLEDGE SHARING METHODS USED WITHIN CONNECTIONS

Table 25: KS methods used for sharing knowledge with considering the generational attributes of egos

Knowledge Receiving Network																	
	Boomers						Gen Xs						Gen Ys				
Rank	CoP1		CoP2		CoP3		CoP1		CoP2		CoP3		CoP1		CoP2		CoP3	
1	PD	44%	PD	49%	Email	50%	PD	38%	PD	47%	PD	46%	PD	39%	PD	52%	PD	45%
2	Email	31%	Email	34%	PD	42%	Email	33%	Email	33%	Email	46%	Email	30%	Email	33%	Email	32%
3	Meeting	18%	Meeting	9%	Report	3%	Meeting	19%	Meeting	13%	Meeting	6%	IM	13%	IM	8%	Meeting	14%
4	Report	6%	Forum	6%	Meeting	3%	IM	4%	IM	3%	Report	2%	Meeting	12%	Forum	3%	Report	9%
5	IM	2%	IM	2%	IM	1%	Report	4%	Forum	2%	IM	0%	Report	5%	Meeting	3%	IM	0%
6	Intranet*	0%	Report	0%	Forum	1%	intranet	1%	Report	1%	Forum	0%	intranet	1%	Report	0%	Forum	0%
Total		108		282		116		359		375		50		138		96		22
Knowledge Providing Network																		
	Boomers						Gen Xs						Gen Ys					
Rank	CoP1		CoP2		CoP3		CoP1		CoP2		CoP3		CoP1		CoP2		CoP3	
1	PD	42%	PD	44%	Email	51%	PD	39%	PD	47%	PD	46%	PD	44%	PD	50%	PD	58%
2	Email	29%	Email	38%	PD	41%	Email	32%	Email	33%	Email	44%	Email	33%	Email	35%	Email	25%
3	Meeting	21%	Meeting	8%	Report	6%	Meeting	19%	Meeting	14%	Meeting	7%	IM	12%	IM	8%	Meeting	17%
4	IM	6%	Forum	8%	Meeting	2%	IM	5%	IM	4%	Report	2%	Meeting	10%	Meeting	5%	IM	0%
5	Report	3%	IM	2%	IM	1%	Report	3%	Forum	2%	IM	0%	intranet	2%	Forum	2%	Forum	0%
6	intranet	0%	Report	0%	Forum	0%	intranet	1%	Report	0%	Forum	0%	Report	0%	Report	0%	Report	0%
Total		126		304		118		420		323		41		103		84		12

*Intranet was an option in CoP1, and community forum (forum) was an option in CoPs 2 and 3.

Table 26: KS methods used for receiving knowledge within inter- and intra-generational connections with considering the generational attributes of egos and alter

	Boomers						Gen Xs						Gen Ys					
	CoP1		**CoP2**		**CoP3**		**CoP1**		**CoP2**		**CoP3**		**CoP1**		**CoP2**		**CoP3**	
Boomers	PD	50%	PD	49%	Email	56%	PD	44%	PD	49%	PD	46%	Email	40%	PD	57%	PD	50%
	Email	30%	Email	33%	PD	40%	Email	30%	Email	35%	Email	41%	PD	33%	Email	29%	Email	38%
	Meeting	10%	Forum	10%	Forum	1%	Meeting	19%	Meeting	11%	Meeting	5%	Meeting	20%	Meeting	14%	Report	13%
	Report	10%	Meeting	7%	Meeting	1%	Report	4%	Forum	3%	Report	5%	Report	7%	Forum	0%	IM	0%
	IM	0%	IM	2%	Report	1%	IM	3%	IM	2%	IM	2%	IM	0%	Report	0%	Forum	0%
	intranet	0%	Report	0%	IM	0%	intranet	0%	Report	0%	Forum	0%	intranet	0%	IM	0%	Meeting	0%
	Total	*20*		*121*		*67*		*73*		*147*		*41*		*15*		*14*		*8*
Gen Xs	Email	42%	PD	43%	PD	50%	PD	40%	PD	48%	Email	50%	PD	39%	PD	56%	Email	75%
	PD	32%	Email	37%	Email	42%	Email	30%	Email	32%	PD	38%	Email	34%	Email	28%	PD	25%
	Meeting	19%	Meeting	15%	Meeting	5%	Meeting	20%	Meeting	12%	Meeting	13%	Meeting	18%	Meeting	12%	IM	0%
	Report	4%	IM	2%	Report	3%	IM	5%	IM	4%	IM	0%	IM	5%	IM	5%	Forum	0%
	IM	3%	Forum	2%	IM	0%	Report	5%	Forum	3%	Forum	0%	Report	3%	Forum	0%	Meeting	0%
	intranet	1%	Report	1%	Forum	0%	intranet	1%	Report	1%	Report	0%	intranet	0%	Report	0%	Report	0%
	Total	*79*		*123*		*38*		*242*		*209*		*8*		*38*		*43*		*4*
Gen Ys	PD	40%	PD	52%	Email	46%	PD	38%	PD	54%	PD	55%	PD	41%	PD	47%	-	-
	Email	35%	Email	39%	PD	38%	Email	27%	Email	32%	Meeting	27%	Email	32%	Email	29%	-	-
	Meeting	15%	Forum	4%	Report	15%	Meeting	15%	IM	7%	Email	18%	IM	24%	IM	24%	-	-
	IM	5%	Meeting	4%	IM	0%	IM	11%	Forum	4%	IM	0%	Meeting	3%	Forum	0%	-	-
	Report	5%	IM	0%	Forum	0%	Report	7%	Meeting	4%	Forum	0%	intranet	0%	Meeting	0%	-	-
	intranet	0%	Report	0%	Meeting	0%	intranet	1%	Report	0%	Report	0%	Report	0%	Report	0%	-	-
	Total	*20*		*23*		*11*		*84*		*56*		*11*		*34*		*17*		*0*

Table 27: KS methods used for providing knowledge within inter- and intra-generational connections with considering the generational attributes of egos and alter

	Boomers						Gen Xs						Gen Ys					
	CoP1		CoP2		CoP3		CoP1		CoP2		CoP3		CoP1		CoP2		CoP3	
Boomers	PD	48%	PD	48%	Email	60%	PD	41%	PD	42%	PD	48%	PD	40%	PD	46%	PD	42%
	Email	33%	Email	37%	PD	35%	Email	29%	Email	39%	Email	41%	Meeting	30%	Email	38%	Email	42%
	Meeting	10%	Forum	8%	Report	5%	Meeting	21%	Meeting	10%	Meeting	5%	Email	20%	Forum	8%	Report	17%
	Report	10%	Meeting	6%	IM	0%	IM	6%	Forum	8%	Report	5%	IM	10%	Meeting	8%	IM	0%
	IM	0%	IM	2%	Forum	0%	Report	2%	IM	2%	IM	2%	intranet	0%	IM	0%	Forum	0%
	intranet	0%	Report	0%	Meeting	0%	intranet	0%	Report	0%	Forum	0%	Report	0%	Report	0%	Meeting	0%
	Total	*21*		*120*		*62*		*85*		*158*		*44*		*20*		*26*		*12*
Gen Xs	Email	40%	PD	42%	PD	52%	PD	42%	PD	46%	Email	50%	PD	37%	PD	59%	Email	67%
	PD	33%	Email	37%	Email	36%	Email	30%	Email	34%	PD	40%	Email	34%	Email	24%	PD	33%
	Meeting	20%	Meeting	15%	Meeting	8%	Meeting	19%	Meeting	13%	Meeting	10%	Meeting	19%	Meeting	12%	IM	0%
	IM	4%	IM	4%	Report	4%	IM	5%	IM	4%	IM	0%	IM	7%	IM	2%	Forum	0%
	Report	2%	Forum	2%	IM	0%	Report	3%	Forum	2%	Forum	0%	Report	3%	Forum	2%	Meeting	0%
	intranet	1%	Report	0%	Forum	0%	intranet	1%	Report	1%	Report	0%	intranet	0%	Report	0%	Report	0%
	Total	*82*		*98*		*25*		*279*		*176*		*10*		*59*		*49*		*6*
Gen Ys	PD	56%	PD	56%	PD	50%	PD	49%	PD	49%	PD	60%	PD	39%	PD	48%	-	-
	Email	33%	Email	33%	Email	50%	Email	36%	Email	36%	Email	20%	Email	35%	Email	33%	-	-
	Meeting	11%	Meeting	11%	IM	0%	IM	7%	IM	7%	Meeting	20%	Meeting	13%	IM	19%	-	-
	IM	0%	IM	0%	Forum	0%	Forum	4%	Forum	4%	IM	0%	intranet	4%	Forum	0%	-	-
	Forum	0%	Forum	0%	Meeting	0%	Meeting	4%	Meeting	4%	Forum	0%	IM	0%	Meeting	0%	-	-
	Report	0%	Report	0%	Report	0%	Report	0%	Report	0%	Report	0%	Report	0%	Report	0%	-	-
	Total	*13*		*18*		*2*		*54*		*45*		*10*		*36*		*21*		-

APPENDIX 3: KNOWLEDGE SHARING METHODS BY GENERATIONS PREFERRED METHODS

Table 28: KS methods preferred to use by different generations (egos)

Knowledge Receiving Network							Knowledge Providing Network					
Boomers												
Rank	**CoP1**		**CoP2**		**CoP3**		**Rank**	**CoP1**		**CoP2**		**CoP3**	
1	Face to face	22%	Workshop	20%	Email	21%	**1**	Face to face	35%	Face to face	24%	Email	31%
2	Email	16%	Face to face	18%	Intranet	18%	**2**	Email	14%	Email	18%	Face to face	13%
3	Workshop	16%	Email	14%	Hardcopy	15%	**3**	Phone	11%	Phone	11%	Intranet	13%
4	Meeting	10%	Hardcopy	13%	Workshop	15%	**4**	Workshop	11%	Workshop	11%	Phone	11%
5	Web space	10%	Intranet	12%	Meeting	8%	**5**	Meeting	9%	Hardcopy	10%	Workshop	10%
6	Phone	9%	Phone	6%	Phone	7%	**6**	Intranet	7%	Intranet	10%	Meeting	9%
7	Hardcopy	7%	Web space	5%	Face to face	7%	**7**	Web space	5%	Meeting	5%	Hardcopy	4%
8	Intranet	3%	Meeting	4%	Blog	4%	**8**	IM	4%	Web space	5%	Blog	4%
9	IM	3%	Video	4%	Web space	1%	**9**	Hardcopy	4%	Video	3%	IM	1%
10	Blog	2%	IM	2%	Video	1%	**10**	Podcast	2%	IM	3%	Web space	1%
11	Podcast	2%	Blog	1%	SIS	1%	**11**	Blog	0%	Blog	0%	Video	1%
12	Video	0%	SIS	1%	IM	1%	**12**	Video	0%	Podcast	0%	SIS	1%
13	SIS	0%	Podcast	0%	Podcast	0%	**13**	SIS	0%	SIS	0%	Podcast	0%
Total		58		263		134	**Total**		57		255		134
Gen Xs													
Rank	**CoP1**		**CoP2**		**CoP3**		**Rank**	**CoP1**		**CoP2**		**CoP3**	
1	Face to face	24%	Face to face	17%	Intranet	22%	**1**	Face to face	26%	Face to face	24%	Email	26%
2	Workshop	17%	Intranet	16%	Email	17%	**2**	Email	18%	Email	21%	Face to face	21%
3	Email	15%	Workshop	15%	Workshop	16%	**3**	Workshop	12%	Intranet	14%	Intranet	16%
4	Phone	7%	Email	14%	Face to face	10%	**4**	Meeting	12%	Workshop	13%	Workshop	11%
5	Meeting	7%	Hardcopy	11%	Hardcopy	8%	**5**	Intranet	8%	Hardcopy	7%	Meeting	7%
6	Web space	6%	Meeting	7%	Meeting	7%	**6**	Phone	7%	Phone	7%	Phone	5%
7	Intranet	5%	Web space	4%	Web space	7%	**7**	Web space	4%	Meeting	6%	Web space	5%

8	Hardcopy	5%	Video	4%	Phone	4%	**8**	Hardcopy	3%	Web space	2%	Video	4%
9	IM	4%	Phone	4%	Video	4%	**9**	SIS	3%	Blog	2%	Hardcopy	2%
10	Video	3%	Blog	2%	Podcast	2%	**10**	IM	3%	IM	2%	Blog	2%
11	SIS	2%	Podcast	2%	IM	2%	**11**	Blog	1%	Video	2%	SIS	1%
12	Blog	2%	IM	2%	Blog	1%	**12**	Podcast	1%	SIS	1%	IM	1%
13	Podcast	2%	SIS	1%	SIS	1%	**13**	Video	1%	Podcast	1%	Podcast	0%
Total		165		432		107	**Total**		144		395		106
Gen Ys													
Rank	**CoP1**		**CoP2**		**CoP3**		**Rank**	**CoP1**		**CoP2**		**CoP3**	
1	Face to face	30%	Face to face	20%	Email	23%	**1**	Face to face	33%	Face to face	26%	Face to face	29%
2	Workshop	19%	Email	17%	Face to face	20%	**2**	Email	15%	Email	22%	Email	26%
3	Email	11%	Hardcopy	13%	Hardcopy	18%	**3**	Web space	12%	Intranet	10%	Meeting	14%
4	Meeting	11%	Intranet	12%	Workshop	15%	**4**	Workshop	9%	Hardcopy	9%	Hardcopy	11%
5	Intranet	8%	Workshop	11%	Web space	8%	**5**	Hardcopy	6%	Workshop	7%	Phone	9%
6	Web space	8%	Video	8%	Phone	5%	**6**	Meeting	6%	IM	7%	Intranet	6%
7	Hardcopy	3%	Web space	5%	Meeting	5%	**7**	Intranet	6%	Meeting	5%	Workshop	3%
8	Phone	3%	IM	4%	Intranet	5%	**8**	IM	6%	Phone	4%	Web space	3%
9	Video	3%	Phone	3%	Video	3%	**9**	Phone	3%	Video	3%	Blog	0%
10	SIS	3%	Meeting	3%	Blog	0%	**10**	SIS	3%	Blog	2%	Podcast	0%
11	IM	3%	Blog	2%	Podcast	0%	**11**	Blog	0%	Web space	2%	Video	0%
12	Blog	0%	SIS	2%	SIS	0%	**12**	Podcast	0%	SIS	2%	SIS	0%
13	Podcast	0%	Podcast	0%	IM	0%	**13**	Video	0%	Podcast	1%	IM	0%
Total		37		210		40	**Total**		33		183		35