

Evaluating the Impact of Real-Time Visualization
on Knowledge Acquisition in Management Meetings

by

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Abstract

This thesis study examines the use of real-time visualization in management meetings to determine how visualization affects knowledge acquisition. The participants in this research are 33 business managers and visual practitioners (n=33) located across five continents who have previously worked with real-time visualization techniques in management meetings. Using a mixed-methods case study design, this research investigated how corporate managers share information in the workplace with visualization tools in real-time. In particular, this research examined how visualization can be used to support knowledge sharing, knowledge creation and knowledge documentation. Key findings indicate that 75.8% of participants report a positive effect of visualization on knowledge acquisition. The different visualization processes used in management meetings are discussed. Future work in this area could investigate how the corporate manager and the visual practitioner could create synergies to embrace interactive visualization processes in management meetings.

Key words: visualization, visual practitioner, manager, meeting, knowledge acquisition.

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*I dedicate this thesis to
my family, my husband, Greg, my children, Meghan and Andrew,
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List of Abbreviations

IQR	Interquartile Range
Mdn	Median
M	Mode
REB	Research Ethics Board
ROI	Return on Investment
UOIT	University of Ontario Institute of Technology

1 Introduction

1.1 Chapter Overview

This chapter provides a brief introduction to this research and describes a rationale and research purpose for how visualization methods, including knowledge sharing, creation and documentation play a role in knowledge management. This chapter's overarching structure is presented in Figure 1.1.

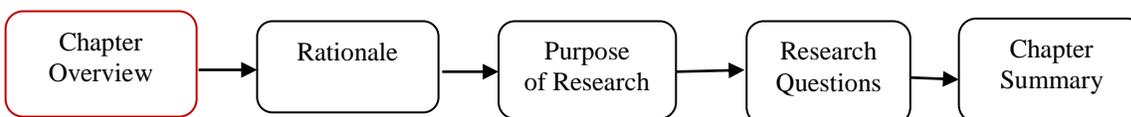


Figure 1.1. Chapter 1 Overview Structure

1.2 Rationale

Within the field of business management, collaborative decision making in meetings, is a crucial task. Ultimately, the quality of the decision process and outcome can have a dramatic impact on a company's performance (Bresciani & Eppler, 2009). Research suggests that visualization plays a pivotal role in supporting knowledge-intensive teamwork (Comi & Eppler, 2011). However, little is known about visualization methods of other domains with potential to management, their requirements, benefits and application areas (Lengler & Eppler, 2007).

Incorporating visual practices within management meetings could potentially improve the quality and the formation of inter-organizational collaboration efforts (Eppler & Bresciani, 2013; Comi & Eppler, 2011; Degnegaard, Degnegaard & Coughlan, 2015). One way to deal

with complexity is with visualization technologies. This could be achieved by adopting creative ways to display information and engaging staff in recognizing complexity and identifying strategic directions with visualization methods (Alexander, Bresciani & Eppler, 2015; Comi, Bischof & Eppler, 2013; Lindquist, 2011). The purpose of visualization is to get a heightened recognition of an issue, awareness about an online community's shared resources, and/or a reflection about oneself (Carpendale, Collins, Dork & Feng, 2013).

One way a meeting facilitator could encourage an interactive discussion would be to incorporate various visualization tools, such as visual templates, which would enable participants to write and/or draw out their thoughts (Alexander et al., 2015; Comi et al., 2013). Organizations can benefit from incorporating visual templates to facilitate and encourage group discussions instead of using plain flipcharts (Alexander et al., 2015). By incorporating visualization templates for collaborative communications in team meetings, it will further engage the meeting participants in an interactive complex problem-solving process (Bresciani & Eppler, 2009; Comi et al., 2013; Degnegaard et al., 2015).

Introducing design-based approaches such as storytelling, brainstorming, prototyping and strategic visualization offers organizations the opportunity to engage in co-creation initiatives to improve organizational communications (Degnegaard et al., 2015). There is evidence that supports how design plays an essential role in unfolding co-creation based business models and how design thinking and strategic visualization can be essential vehicles in designing for co-creation (Comi et al., 2013; Degnegaard et al., 2015). Through the design and delivery of multimedia visualization training in meetings, managers will have a variety of opportunities to augment their learning for improved communications and decision-making (Brumberger, 2007; Mayer & Massa, 2003).

Limited research has examined the mechanics of image-enabled social interaction (Alexander et al., 2015). However, several studies have reported that the use of interactive visualization leads to statistically significant better performances (Alexander et al., 2015; Bresciani & Eppler, 2009; Degnegaard et al., 2015). Team performance and satisfaction can be further enhanced through knowledge sharing and recall of information with visualization tools (Bresciani & Eppler, 2009; Brumberger, 2007; Comi & Eppler, 2011; Degnegaard et al., 2015).

Visualization provides a powerful mechanism to engage the participant, increase the quality of knowledge sharing in face-to-face conversations and shape the experiences of other participants (Carpendale et al., 2013; Comi et al., 2013; Eppler & Burkhard, 2007). Introducing visualization in real-time during a meeting can offer a powerful way for organizational leaders to encourage synchronous collaboration for group knowledge sharing (Eppler & Bresciani, 2013). By engaging visualization methods in the meeting process, it will allow meeting participants the ability to manage their uneasiness and uncertainty in a complex problem-solving situation (Degnegaard et al., 2015; Lindquist, 2011). Visualization can also stimulate conversation and offer a significant positive impact on the process and outcome of knowledge sharing in meetings (Alexander et al., 2015; Comi et al., 2013).

Research on real-time visualization has been conducted almost exclusively on higher education (Bresciani & Eppler, 2009; Brumberger, 2007; Mayer & Massa, 2003). The research indicates that one of the weaknesses within the field of visualization is a concentration of numerous studies that use undergraduate students instead of having experienced managers as research subjects (Bresciani & Eppler, 2009; Mayer & Massa, 2003).

Future research should incorporate managers as subjects to show how the benefits and the extent to which visualization offers added value for improving communications (Degnegaard et al.; Lindquist, 2011). Managers in organizations with several years' experience have the opportunity to share how visualization impacts the process and outcome of experience sharing in meetings (Alexander et al., 2015). Scholars who include managers as subjects in future research, focusing on strategic planning as a topic of discussion, offer a reasonable degree of external validity (Bresciani & Eppler, 2009).

The field of visualization is diverse, and visualization offers a potential to help inform and improve awareness of issues, analysis, performance, recall, knowledge sharing, problem solving and decision-making for managers (Bresciani & Eppler, 2009; Brumberger, 2007; Degnegaard et al., 2015; Lindquist, 2011). By combining graphics and visual templates to intersect with the facilitation of meetings and subsequent strategic thinking process, it can offer potential for improved sharing of information through various multimedia channels (Lindquist, 2015; Bresciani & Eppler, 2009).

The most widely used format of visualization today in management activities has been limited to PowerPoint presentations of statistical charts and information, rather than implement novel visualization methods such as diagrams and sketches (Eppler & Bresciani, 2013). This might be one reason why PowerPoint continues to be a dominant communication tool in business today (Kernbach, Bresciani & Eppler, 2015). Organizations that incorporate real-time visualization methods through an interactive learning environment will encourage their human resources to fully participate interactively in management meetings (Alexander et al., 2015; Comi & Eppler, 2011; Eppler & Burkhard, 2007). Business leaders that embrace visualization methods for meeting facilitation will improve the quality of knowledge sharing

and lead their company human resources to greater team performance in inter-organizational meetings in the future (Comi & Eppler, 2011; Degnegaard et al., 2015).

1.3 Purpose of the Research Study

This research focuses on how managers learn in a corporate setting through the documentation and sharing of information with various visualization tools. The review of the literature explores the following areas: visualization methods for knowledge acquisition, knowledge sharing, knowledge documentation, advantages and disadvantages of visualization, communication, performance levels and interpretation of visualization tools.

This research also explores the common pitfalls and potential disadvantages of visual representation use in management meetings including how sketch-based approaches are incorporated in meetings for knowledge acquisition. Additionally, this research outlines how both the business manager and the visual practitioner specialist interpret the advantages and disadvantages of real-time visualization use in management meetings. The methodology section will outline the findings, which includes the participants, their experiences with visualization methods, the data collection methods and data analysis are reported. A comparison by the researcher based on the findings of this research is compared to the review of literature. In the final summation, the researcher proposes recommendations for future research.

1.4 Research Goal & Questions

The goal for this thesis study is to explore how real-time visualization impacts knowledge acquisition in management meetings. Specifically, the following four research questions will be addressed in this study:

1. How does visualization affect knowledge acquisition in management meetings?
2. What are the advantages of visualization in management meetings?
3. What are the disadvantages of visualization in management meetings?
4. What are the attitudes of managers towards the use of visualization in management meetings?

1.5 Chapter Summary

In this chapter, the researcher provided an introduction and overview of the research topic: Evaluating the Impact of Real-Time Visualization on Knowledge Acquisition in Management Meetings. The purpose of the research study, a rationale of the key literature and the research questions were presented. The following chapter offers an overview of the background literature in this research and a conceptual framework that guided this research.

2 Review of the Literature

2.1 Chapter Overview

Chapter 1 provided an introduction to the research and an overview of this thesis study. This chapter provides a review of the literature in the areas that is focused on the use of visualization methods for knowledge acquisition in management meetings. This chapter's overview structure is presented in Figure 2.1.

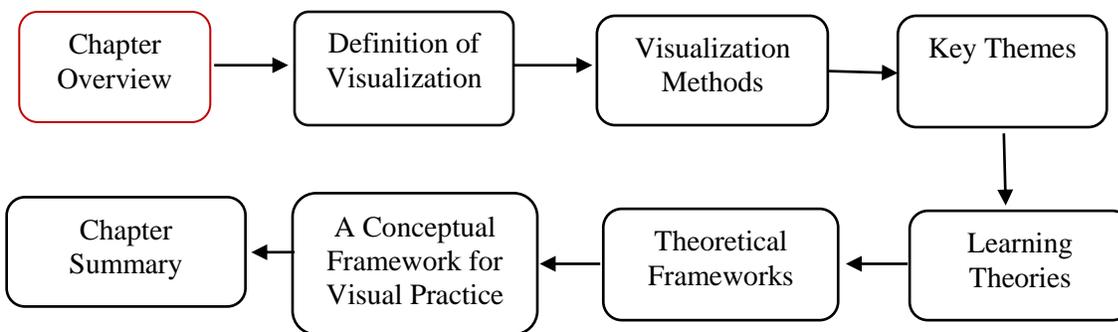


Figure 2.1. Chapter 2 Overview Structure

2.2 Definition of Visualization

Visualization often means formulating ideas and concepts with graphic representations of data and information, in a meaningful structured manner for enhancing the quality of collaboration (Eppler & Platts, 2009; Eppler & Bresciani, 2012). By employing the use of visual representations, individuals are able to improve the construct, creation and sharing of information across many channels (Eppler & Burkhard, 2004; Eppler & Burkhard, 2007). Though, how does each individual interpret a visual representation? Could visualization be perceived as a universal language? According to Eppler and Burkhard (2004), a visual representation could serve different functions, which is entirely dependent on the

structure and delivery of the visual artifact. This literature review outlines four major themes of how *communication*, *performance*, *challenges* and *interpretation* are affected by the use of visualization methods.

2.3 Visualization Methods for Knowledge Acquisition

This thesis research highlights four previous literature reviews that were conducted and focused on the use of visualization methods for knowledge acquisition in management meetings (Mengis, & Eppler, M, 2005; Pfister, & Eppler, 2012; Brumberger, 2007; Bresciani, & Eppler, 2015). Each of these literature reviews will be discussed herein.

The first review conducted by Mengis and Eppler (2005) examined knowledge sharing in management conversations within organizations on research between 1989 – 2004. The authors concentrated on four research streams that study conversations in relation to knowledge processes, which include; knowledge management, organizational learning, decision making, and change management. Their findings indicated that by framing knowledge as a process of knowing, conversations become central for the processes of knowledge sharing and sense-making (Mengis & Eppler, 2005). Mengis and Eppler (2005) proposed a set of six dimensions of conversation according to which the management of these conversations could be structured. The six dimensions the authors suggest are; (a) the message, (b) the conversation process, (c) the conversational intent, (d) group dynamics, (e) mental models, and (f) the outer context (Mengis & Eppler, 2005).

Finally, Mengis and Eppler (2005) offer suggestions for further research that will focus on future contributions surrounding conversational dynamics from a knowledge perspective

and to further investigate alternative means for improving the quality of conversations in management (Mengis & Eppler, 2005).

The second review conducted by Pfister and Eppler (2012), researched sketch-based approaches for managing knowledge in organizations between 1995 – 2009. The authors' aim was to review the benefits of sketching and/or collaborative hand drawings for knowledge creation, knowledge sharing, and knowledge documentation. The design and methodology concentrated on twenty-three peer-reviewed articles in the fields of design, psychology, and computer science that document the multiple advantages of sketch-based approaches for managing knowledge in organizations (Pfister & Eppler, 2012).

The authors' findings indicate a comprehensive list of benefits which support the three relevant tasks in knowledge management, knowledge creation, knowledge sharing and knowledge documentation (Pfister & Eppler, 2012). They cite that this list of benefits shows simple and effective ways for participants to create hand drawings in order to enhance existing knowledge management practices (Pfister & Eppler, 2012). Furthermore, they found that the most frequently mentioned benefit across all disciplines is the ability of sketches to facilitate information processing and support communication, which they found predominantly supports knowledge sharing, and knowledge creation (Pfister & Eppler, 2012).

Finally, the authors report that the research shows that usage of sketching is limited when it comes to meetings with remote teams as hand drawings are not immediately available electronically and always need to get either scanned or digitally copied (Pfister & Eppler, 2012). They further highlighted that the often overlooked role of informal drawings in team knowledge management and encourage future research that will examine visual practice for knowledge creation and sharing (Pfister & Eppler, 2012). Additional areas of research for consideration is

an examination to learn and understand how sketching in management meetings, through a variety of interdisciplinary research efforts, will contribute to knowledge acquisition (Pfister & Eppler, 2012).

The third review conducted by Brumberger (2007) examined the literature on the pedagogical practices of visually oriented disciplines to identify strategies for helping students develop the ambidexterity of thought needed for the communication tasks of today's workplace (Brumberger, 2007). The literature review analyzed sixty-four peer-reviewed articles between 1972 – 2006. The author outlined a recap of critical issues that divide the visual from the verbal, defining visual thinking and including how the implementation of visual communication in the professional field has increased (Brumberger, 2007).

The authors' findings suggest that visual thinking is an intuitive and intellectual process of visual idea generation and problem solving that begins with perception. Brumberger (2007) also cites that there are two types of sketching that are essential to problem-solving; initial sketching and subsequent sketching (Brumberger, 2007). The author further suggests that through a process of making the familiar strange, students can learn that design is a process of problem-solving (Brumberger, 2007).

Finally, the author concludes from the literature review that visual communication is an important component of professional communication, particularly because it marries both print and digital texts and therefore critical to the area of multiliteracies (Brumberger, 2007). Further to this, the author suggests approaches for reducing the divide between word and image, and creating a better balance between verbal and visual modes for students, that will

ultimately prepare them better for various multimodal ways of communicating in the professional field (Brumberger, 2007).

The fourth review conducted by Bresciani and Eppler (2015), focused research on an overview of the common pitfalls and potential disadvantages of visual representations. The authors analyzed 51 peer-reviewed articles between 1972 – 2007. They focused on the visual representation of information in six main fields of statistical graphic representations, visual literacy and visual communication, information visualization and human–computer interaction, management studies, and cross-cultural studies related to visualization (Bresciani & Eppler, 2015, p.2).

The goal of the literature review is to identify and classify the key problematic issues that exist when creating or interpreting visual representations (Bresciani & Eppler, 2015). The literature review also focused on how to improve visual literacy by structuring one's understanding of the possible limitations of a graphic representation. Bresciani and Eppler (2015) proposed a classification of visualization errors and disadvantages with two causes of pitfalls, the designer (encoding) and the reader (decoding) (Bresciani & Eppler, 2015). The authors note three types of negative effects within this classification as cognitive, emotional, and social (Bresciani & Eppler, 2015). They further suggest that this classification of visualization errors structures the many factors that can potentially make a graphic representation dysfunctional (Bresciani & Eppler, 2015).

Finally, the authors suggest that the limitations of their research include the lack of scientific testing for its comprehensiveness and usability (Bresciani & Eppler, 2015). They report that the next step in this research area is the testing of the classification through actual

testing, that is, by comparing the performances of the designers and readers in two areas: participants who use and participants who do not use the classification (Bresciani & Eppler, 2015). They further suggest that it is important to create a ranking system in order to identify the pitfalls according to how common or how severe they are for both the designer and the user (Bresciani & Eppler, 2015).

2.4 Key Themes of Visualization for Knowledge Acquisition

From the researcher's perspective, there are four key themes that emerged from the review of the literature that supported the research questions in this study. Each theme has its own unique perspective on how visualization plays a role for knowledge acquisition in management meetings. In the following sections, the themes (a) communication, (b) performance, (c) challenges and (d) interpretation are explored in order to consider how they impact knowledge acquisition in management meetings.

2.4.1 Communication

In the first theme *communication*, a common thread emerges within the literature that discusses how knowledge sharing with visual representations can offer a new kind of knowledge. Specifically, since each remark can bring new meaning, it helps to re-define the development of a conversation (Mengis & Eppler, 2005) not simply to transfer knowledge, but to regenerate it in a new context. For example, Pfister & Eppler (2012) argue that visual sketch representations serve on an interactive level and assist communications that refine ideas further and capture pertinent knowledge from many sources. They further discuss how sketching can improve communication and collaboration in teams because it allows team

members to simultaneously share ideas visually which “helps them to clear up misunderstandings and to enhance simple ideas into complex ones” (Pfister & Eppler, 2012, p. 378). Therefore, it could be argued that by incorporating visualization methods in management meetings, conversations can offer an important means of how managers learn, share information and communicate in a more productive and collaborative manner (Mengis & Eppler, 2005; Brumberger, 2007).

Management conversations are not “limited to a merely additive back and forth exchange of information” or of knowledge. “It can also afford the generation of new knowledge, since each remark can yield new meaning as it is resituated in the evolving context of the conversation” (Mengis & Eppler, 2005, p. 2). In other words, managers could look at building strategic conversations with visualization methods in a way that will enhance the sharing of information and embrace a comfortable and more open environment, which in return would nurture higher-order thinking skills (Mengis & Eppler, 2005) and enhance collaboration in team-work (Pfister & Eppler, 2012).

It is further suggested by Brumberger (2007) that the use of visual thinking methods with visual representations can act “as a mode of active and analytical process of perceiving, interpreting, and producing” visual messages (p. 379). It is through this analysis process that visualization could potentially be most valuable to managers in communications because of the cognitive benefits (Comi et al., 2013; Eppler & Platts, 2009) that include “facilitating elicitation and synthesis of information, enabling new perspectives to allow better, more exhaustive comparisons and facilitating easier recall and sequencing” (Eppler & Platts, 2009, p. 43).

More importantly, this process of analysis allows managers the ability to synthesize and make sense of the information, and thus, enabling the manager to process more information and potentially avoiding information overload (Eppler & Platts, 2009), which is a common problem in knowledge-intensive organizations (Mengis & Eppler, 2005). In short, visualization methods used in management meetings offer participants the ability to change conversational behaviour (Mengis & Eppler, 2005), visually identify the parameters of group discussion and also track progress (Eppler & Platts, 2009; Pfister & Eppler, 2012), thereby, supporting inter-organizational development and team-work (Comi et al., 2013).

2.4.2 Performance

In the second theme *performance*, a manager's engagement and decision-making, including the outcomes of decision-making was a common thread in the literature when considering some advantages of how visualization impacts a manager's knowledge acquisition.

In the specific context of performance levels, visual representations that are introduced in management meetings could serve as a shared focus of attention for managers and make group collaboration a continuous, on-going process and therefore continually promote interactivity and involvement (Pfister & Eppler, 2012). In this setting, visualization could affect an emotional response by creating engagement (Bresciani et al., 2011) and produce conversations that create a co-creation of meaning (Brumberger, 2007) that will extract the key points of group discussion and decision-making in team work (Pfister & Eppler, 2012).

As Eppler & Burkhard (2004) claimed, and as Brumberger (2007) confirmed, sketching in various modes are essential to problem-solving and help to "transform conceptual knowledge into operational knowledge" (Pfister & Eppler, 2012, p.377). As a result, the

process of incorporating sketching as a mode of designing in management meetings could potentially offer effective problem-solving and decision-making (Brumberger, 2007) thereby, ultimately demonstrating how visualization methods could contribute actively to shape the co-creation of information and augment performance levels (Comi et al., 2013).

Furthermore, the value of sketching in management meetings will create a means to synthesize large amounts of information (Eppler & Burkhard, 2004), and to increase knowledge sharing (Brumberger, 2007; Eppler & Burkhard, 2004) which allows managers to get encouraged to offer feedback on information and ideas in group work (Pfister & Eppler, 2012). As an example, during a strategy planning session, managers may suggest multiple solutions to a problem, and then collectively decide on one best rationale for the problem (Brumberger, 2007).

With regards to performance levels, the research indicates that visualization use in meetings creates a way to enhance problem-solving and decision-making among meeting participants (Brumberger, 2007; Eppler & Burkhard, 2004; Comi et al., 2013; Pfister & Eppler, 2012). For this reason, organizational leaders who adopt visualization methods for meeting planning and facilitation, and incorporate sketching as a means to assist in synthesizing information, memory recall and communications (Pfister & Eppler, 2012), will open the doors for employees to enhance “organizational learning, change and innovation management” (Mengis & Eppler, p. 10). Furthermore, in the instances where visualization is used for idea generation (Brumberger, 2007; Pfister & Eppler, 2012), group interaction and group communications (Mengis & Eppler, 2005), organizational leaders create opportunities for better engagement as well as knowledge management among meetings participants (Brumberger, 2007; Eppler & Burkhard, 2004; Pfister & Eppler, 2012).

2.4.3 Challenges

In the third theme *challenges*, the literature explores certain disadvantages and potential problems that are created by incorporating visualization in management meetings; most notably, knowledge sharing that includes, but is not limited to an individual's interpretation of visualization use, language and cultural differences, visualization for remote meetings, reactions to a new mode of meeting facilitation and learning how to transform hard-copy images into a digital representation. (Bresciani & Eppler, 2015; Mengis & Eppler, 2005; Brumberger, 2007; Pfister & Eppler, 2012).

Bresciani and Eppler (2015) consider a challenge to visualization use in management meetings is in part due to the “encoding of the facilitator and the decoding of the participant” (p. 3), that is, the meeting facilitator could make mistakes in presenting the visual representation and the meeting participant could misinterpret the meaning of the visual representation as presented by the facilitator. In one example, Bresciani and Eppler (2015) consider a three-point classification of “the effects of visualization drawbacks” (p.7) that surround the cognitive, emotional and social effects for the encoding and decoding stages of visualization representations. This three-point classification not only shows disadvantages, but also how the disadvantages may be interpreted. The researcher highlights some of the key highlights of Bresciani & Eppler's (2015) three-point classification based on the review of the literature presented in Table 1.

Table 1. List of Visual Representation Challenges

<u>Disadvantage</u>	<u>Author(s)</u>	<u>Description</u>
<u>Cognitive (encoding)</u>		
Confusion	(Eppler & Burkhard, 2004)	Visualizations that do not have a clear focus and accompanying text may confuse the manager.
<u>Cognitive (decoding)</u>		
Difficult to understand	(Eppler & Burkhard, 2004)	Facilitator responsible for knowledge transfer must ensure that information is shared in right context and at appropriate time.
<u>Emotional (encoding)</u>		
Wrong use of color	(Bresciani & Eppler, 2015)	A combination of different colors may make a visual difficult to read or confusing.
<u>Emotional (decoding)</u>		
Prior knowledge and experience	(Eppler & Burkhard, 2004)	A manager's prior knowledge and experience in regards to their expectations and desired outcomes should be taken into consideration when choosing a visual representation.
<u>Social (encoding)</u>		
Hierarchy, exercise of power	(Mengis & Eppler, 2005)	Group dynamics often provoke political conversations and mistrust among meeting participants, as a result many individuals may not participate in the group conversation.
<u>Social (decoding)</u>		
Change in behavior	(Mengis & Eppler, 2005)	Visualization use in team work may alter the participant's behavior.

Adapted from (Bresciani & Eppler, 2015)

An important consideration to note is that organizations that introduce visuals in management meetings for knowledge management, may inadvertently inhibit knowledge from being shared and further developed as individuals may experience “fear or a sense of inferiority that may impede equal participation” (Mengis & Eppler, 2005, p.13) in collaborative team work. For example, meeting participants may not want to offer their

feedback on a group discussion point as they fear it may interrupt the collective decision-making of the majority of team members (Mengis & Eppler, 2005). Also, by incorporating visuals in group work, a meeting participant's behavior could also be further disrupted as the participant may pay more attention to the actual visual rather than listening to the facilitator and participating in the group discussion (Bresciani & Eppler, 2015).

Finally, it is important to note, that while communication problems may impede the successful sharing of knowledge in management meetings (Bresciani & Eppler, 2015; Mengis & Eppler, 2005), knowledge-intensive management meetings could benefit from a clearer plan of action and a more streamlined focused strategy plan (Comi et al., 2013; Eppler & Burkhard, 2005; Mengis & Eppler, 2005), thereby creating avenues of improved inter-organizational team work and improved communications (Comi et al., 2013).

2.4.4 Interpretation

In the fourth theme, *interpretation*, individuals may experience various different attitudes towards the use of visualization in management meetings as a result of their interpretation towards the creation and sharing of visual representations.

In the previous section, the researcher reviewed how Bresciani and Eppler (2015) propose an implementation of the encoding and decoding classification model that outlines some of the challenges of how individuals interpret and understand visual representations. They further discuss how creating a classification model may assist as a “guideline to describe the solutions to counteract the negative effects of interpretation” (Bresciani & Eppler, 2015, p. 8).

Facilitators that present visual representations that encourage interactivity within group discussion, offer individuals the ability to see the visualized information from alternative viewpoints, and therefore, will ultimately encourage productive thinking and group collaboration (Brumberger, 2007). As an example, Figure 2.2 illustrates a visual representation outlining a corporate strategy plan that targets specific points of a yearly plan for the mandated priorities of a volunteer program. While the visual notes on the chart are described in text and image format, individuals at different levels of an organization may interpret the information in different perspectives (Bresciani & Eppler, 2015). As an example, as illustrated in Figure 2.2, some managers may interpret the circles in each column as important target information; however, others may view the green color text as the more important information on the sketch. However, if the sketch is reviewed from a different viewpoint, then one could also interpret the rectangles under each circle as the focus area of the strategy plan and all other visual and text information plays a support role.



Miller (2013)

Figure 2.2. Priorities Mandate – Volunteer Program

In summary, visual communication should be considered as an important component of professional communication (Mengis & Eppler, 2005) and therefore, an understanding of the importance of sharing information in teams (Alexander et al., 2015; Brumberger, 2007; Cummings, 2003; Eppler & Platts, 2009; Pfister & Eppler, 2012) with various visualization methods such as drawings, pictures, maps and software tools will potentially enable the manager to learn and share information more effectively across their organizations.

It is through sketching ideas (Eppler & Burkhard, 2004) that will help to extract information within group work and help define the discussion points in a clear and understandable language and help engage the meeting participants to enhance their communications and keep them focused and concentrated in meetings (Pfister & Eppler, 2012). Furthermore, sketching can also support the evaluation of the design process and co-creation of ideas in planning by allowing teams to concentrate on the bigger picture (Bresciani & Eppler, 2015; Brumberger, 2007; Comi et al., 2013) thus, creating a roadmap to “structure and organize information and coordinate group dialogue” (Comi et al., 2013, p. 1433).

2.5 Learning Theories

2.5.1 The Adult Learning Theory – Andragogy

Malcolm Knowles was an author and theorist in the field of adult education in the United States in the 1950s and later years. In his work, Knowles (1980) defined “*andragogy* as the art and science of adult education, whereas in contrast, *pedagogy* is the art and science of teaching children” (p. 43). It is during this time that he produced a number of publications that offered critical arguments about the need to recognize the differences between adult and child learners. As a result, the term andragogy was used to describe a teaching method that

focused on a set of specific characteristics of the adult learner also referred to as the mature learner.

The term andragogy refers to “man led” rather than pedagogy which has the root *ped* meaning “child”. Therefore, pedagogy could be best defined as a process that is student-focused and one of dependency where the student only needs to learn what is taught by the teacher and any prior knowledge is not necessary for their learning (Knowles, 1980). In contrast to this, andragogy is geared toward the instructor acting as a facilitator who guides the learners through a process of understanding and self-directed inquiry for learning (Knowles, 1980, p. 43).

Knowles (1980) describes an adult learning environment as one that is welcoming, where ‘adults feel accepted, respected and supported in their learning’ (p. 47). He further describes the process of adults learning as either alone or with others to acquire and share new knowledge to enhance their own self-development and that the role of learning and teaching is one of mutual responsibility of both the teacher and the adult learner (Knowles, 1980)

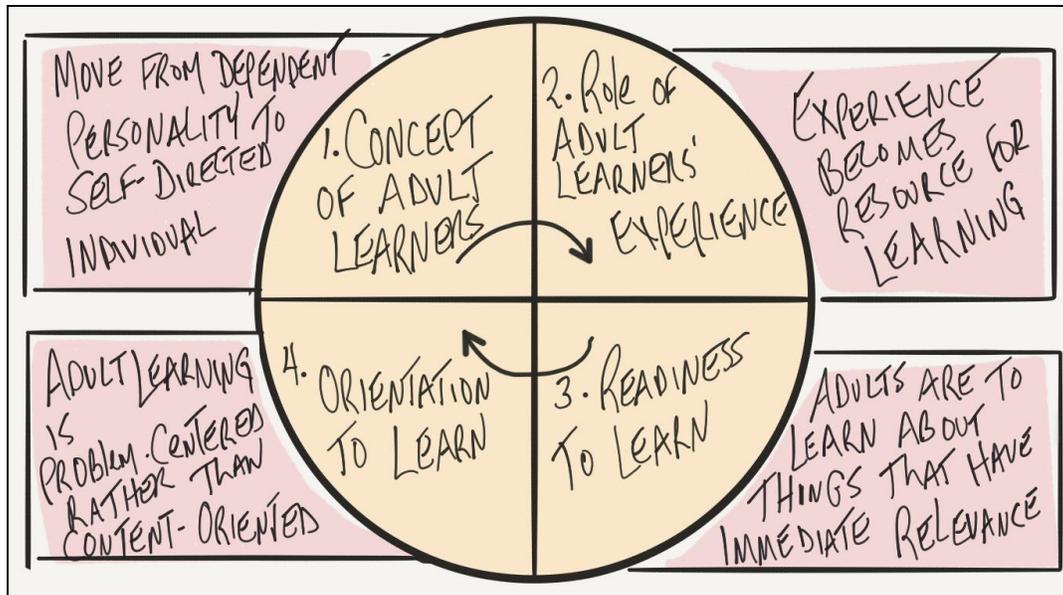
Knowles theorizes that there are four guiding principles for adult learning that describe the characteristics of adult learners that are different from the assumptions about child learners (Knowles, 1980). These four assumptions of the adult learner and the potential implications for visualization in the workforce are:

1. *Concept of the Learner*: Adults need to be involved in the planning and evaluation of their instruction (Knowles, 1980), that is the mature learner needs to be involved in the creation of real-time visualization representations for sharing and documenting of information in meetings.

2. *Role of the Learner's Experience*: that experience (including mistakes) provides the basis for the learning activities, therefore meaning that the mature learner will learn more by experience and experimental means versus taking on a more passive role in their learning (Knowles, 1980). In real-time visualization meetings, it would be important to encourage the mature learner to reflect on their experience and engage more in the creation of the real-time visualization representations.

3. *Readiness to Learn*: adults are most interested in learning subjects that have immediate relevance and impact to their job or personal life (Knowles, 1980). Therefore, if real-time visualization is to be readily accepted and successfully used in management meetings, the mature learner will need to see it as an important learning tool and they will need to be ready to learn how visualization methods could potentially augment their knowledge acquisition.

4. *Orientation to Learning*: adult learning is problem-centered rather than content-oriented and the mature learner tends to view learning as a coping mechanism for everyday life issues (Knowles, 1980), therefore, when considering different avenues for introducing real-time visualization methods in management meetings, the mature learner will need to see the long term benefits and applicability to their immediate learning. Knowles' four assumptions of characteristics of adult learning are illustrated in Figure 2.3.



Adapted from Knowles (1980)

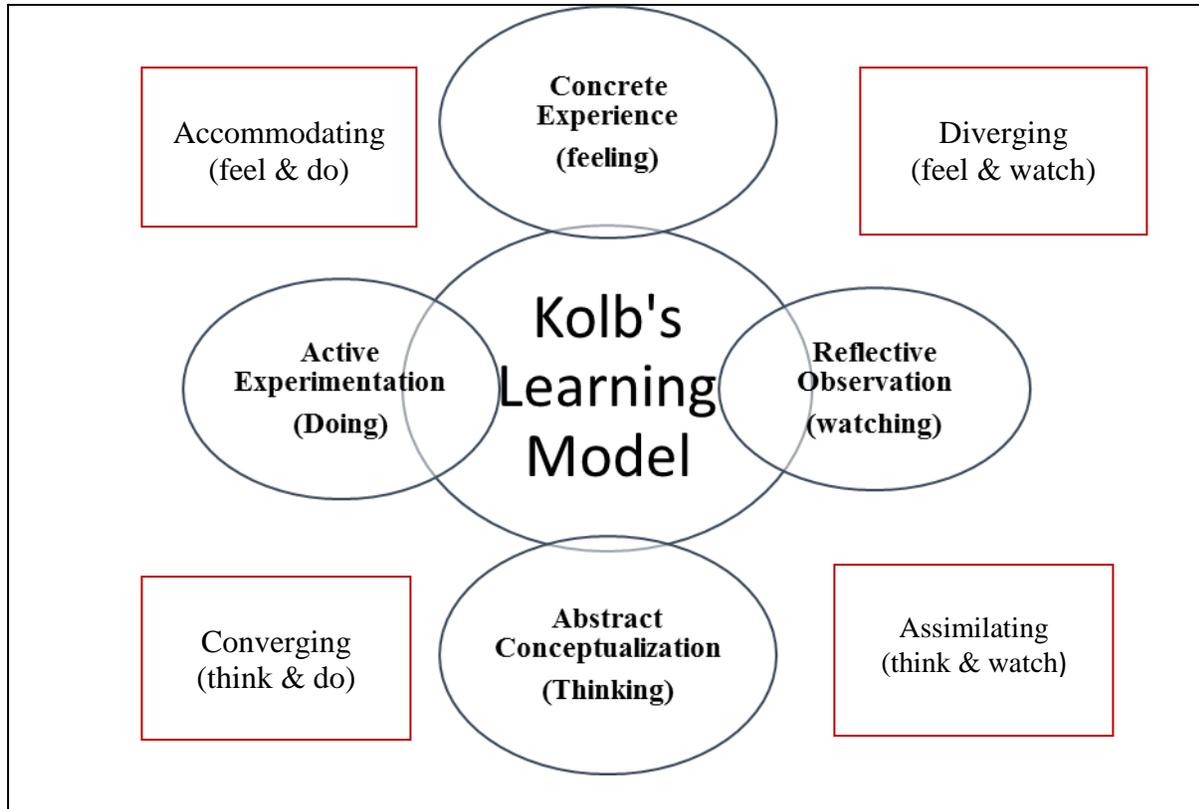
Figure 2.3. Knowles' Four Assumptions of Adult Learning – Andragogy

2.5.2 The Experiential Learning Theory

Following Knowles, David Kolb (1984) further developed the adult learning theory, suggesting that learning is an ongoing process and suggests how some behavioural theories of adult learning do not fully explain the adult learning process. Kolb (1984) defines experiential learning as an “holistic integrative perspective on learning that combines experience, cognition, perception and behaviour” (p. 21) and is “the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience” (p. 41). The basic premise of this approach by Kolb is that a number of factors can influence an individual’s learning and therefore must be considered.

This experiential learning model recommended by Kolb (1984) was based upon three different but interconnected methods to learning: “Lewin’s model of action research, Dewey’s

model of learning and Piaget's model of learning and cognitive development" (p. 21). The Kolb model learning cycle is presented in Figure 2.4.



Adapted from Kolb (1984)

Figure 2.4. Kolb (1984) Learning Cycle

This learning model suggests that any learning opportunity is a “continuous process grounded in experience” (Kolb, 1984, p. 27); hence, learning requires an experience by the learner, which in turn is reflected upon, conceptualized and then further explored, resulting in learning being developed through experience, cognition, perception and behaviour (Kolb, 1984). Likewise, in knowledge sharing situations, the manager may also prefer to choose certain parts of the model to manage their own learning and “choose which set of learning

abilities he or she will use in a specific learning situation” (Kolb, Boyatzis & Mainemelis, 1999, p.3).

This further supports Kolb’s (1984) theory of “all learning is relearning” (p. 28) as the role of the facilitator should be to focus on helping individuals to create new ideas and thoughts, and that the manager would also need to take a more active role to change or eliminate old habits and ways of thinking. As an example, in group conversations, the manager may decide to start at the reflection observation stage of the learning model, observing the facilitator create sketch templates and documenting information (Baker, Jensen, Kolb, 1997). Following, the manager could potentially move directly to the active experimentation stage of sketching, by creating their own visual sketch summaries of the group discussion and ultimately transforming learning into experience (Baker, Jensen, Kolb, 1997).

In the corporate setting, the manager can choose a learning style that is best oriented towards their own preferred learning method (Kolb, 1984). Therefore, as each individual responds differently in a learning setting, it is important to note that a facilitator should be flexible and consider the different learning styles of individual managers. The facilitator should design and adapt the meeting activities in a manner that will best augment individual and group learning in a meeting setting.

2.6 A Framework for Knowledge Visualization

There are various theoretical frameworks that integrate the creation, sharing, and utilization of information and knowledge with visualization methods. Burkhard (2005)

examines how visualization can offer an effective synergy of co-creation and transfer of information and knowledge to improve learning. This visualization transfer and co-creation is embedded in four perspectives: “(1) Why should knowledge be visualized? (aim/function), (2) What type of knowledge needs to be visualized? (content), (3) Who is being addressed? (recipient), and (4) which is the best method to visualize this knowledge? (medium)” (Burkhard, 2005, p. 232).

In this framework for knowledge visualization, Burkhard (2005) identifies four perspectives for consideration when creating visualizations for knowledge sharing. The first, *function perspective* identifies the reason a visual artifact functions (Burkhard, 2005). Burkhard (2005) identifies the CARMEN-acronym developed by Eppler & Burkhard (2004) that highlights the “*coordination, attention, recall, motivation, elaboration and new insights*” (Burkhard, 2005, p. 530) as functions that embrace the cognitive, emotional and social stages in processing visual representations (Burkhard, 2005; Eppler, 2009). As a result, by introducing and creating a CARMEN approach (Eppler & Burkhard, 2004) in management meetings, facilitators offer managers opportunities for enhancing knowledge sharing and improving inter-organizational teamwork (Comi et al., 2013). Furthermore, by introducing and sharing visual representations in management meetings, facilitators create a means to synthesize information (Brumberger, 2007; Eppler, 2009; Eppler & Burkhard, 2004) and visualize organizational strategy through group work (Bresciani & Eppler, 2013), thereby encouraging managers to offer feedback on the visual representation design and creating an organizational structure of information (Eppler & Burkhard, 2004).

The *knowledge perspective* describes the format of the content, that is, the information that is needed to be shared in group work (Burkhard, 2005). In this perspective, Burkhard

(2005) discusses how to identify what type of information needs to be shared by focusing on the following questions; “know-what, know-how, know-why, know-where and know-who” (p. 530). In this perspective, managers want to know the facts as presented in a meeting, as well as understand how things are done in a certain manner; they are also curious about why things happen and where information can be acquired so they can become experts in the knowledge shared in group work (Burkhard, 2005).

The *recipient perspective* identifies the background and/or history of participants and may include “an individual, a team, an organization (one culture) or a network (different cultures)” (Burkhard, 2005, p. 530). Burkhard (2005) discusses how the facilitator should understand the background of the meeting participants in order to choose the best visualization method for knowledge sharing.

And lastly, the *visualization perspective* outlines the various visual types in relation to each individual’s characteristics (Burkhard, 2005). This visualization perspective is divided into seven categories: (a) sketches, (b) diagrams, (c) maps, (d) images, (e) objects, (f) interactive visualizations and (g) stories (Burkhard, 2005). Each of these seven categories offer the facilitator options to choose an appropriate visualization type (Kolb, 1984) to match up with the recipient type perspective category for knowledge sharing and knowledge documentation in meetings. The knowledge visualization framework is presented in Table 2.

Table 2. The Knowledge Visualization Framework

Function	Knowledge Type	Recipient	Visualization Type
Coordination	Know-what	Individual	Sketch
Attention	Know-how	Group	Diagram
Recall	Know-why	Organization	Image
Motivation	Know-where	Network	Map
Elaboration	Know-who		Object
New Insight			Interactive Visualization
			Story

(Burkhard, 2005, p. 529)

2.7 A Framework for Management Strategic Planning

This framework discusses the relationships between the challenges and advantages encountered during a managerial strategy planning meeting. Eppler and Platts (2009), theorize that there are three actions that create enormous challenges for managers during the strategic planning process. The first, *cognitive challenges* employs managerial thinking, which includes the synthesis and analysis of information (Eppler & Platts, 2009). The second, *social challenges*, encompasses managerial communication and coordination that identify different views and assumptions on information and the third action, *emotional challenges*, employs a manager's ability to motivate and engage their peers and employees on identified strategy plans (Eppler & Platts, 2009). Eppler and Platts (2009) hypothesize that each of these three actions can offer significant advantages to knowledge acquisition in strategy planning meetings by incorporating visualization tools to create graphic representations of data, information and knowledge. These challenges and benefits are presented in Table 3.

Table 3. Strategizing challenges and corresponding strengths of visualization

Characteristics of Strategizing	Corresponding Strengths of Visualization
<hr/>	
<u>Cognitive Challenges</u>	<u>Cognitive Benefits</u>
Struggling with information overload	Facilitating elicitation and synthesis
Stuck in old view points	Enabling new perspectives
Biased comparisons and evaluations	Better, more exhaustive comparisons
Paralysis by Analysis	Easier recall and sequencing
<hr/>	
<u>Social Challenges</u>	<u>Social Benefits</u>
Diverging views or assumptions	Integrating different perspective
Incomplete communication of basic assumptions	Assisting mutual understanding
Un-coordinated strategic action	Tracking, showing interdependencies
<hr/>	
<u>Emotional Challenges</u>	<u>Emotional Benefits</u>
Lacking identification with strategy	Creating involvement and engagement
Creating identification with (abstract) strategy	Providing inspiration
Persuading employees of the strategy	Providing convincing communication
<hr/>	

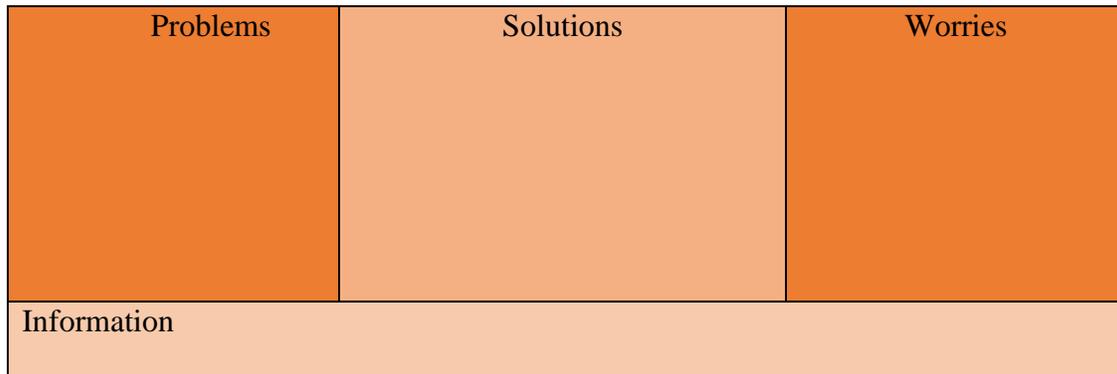
(Eppler & Platts, 2009, p.44)

2.8 A Framework for Practitioners

Alexander, Bresciani and Eppler (2015) analyze how a four-tiered level scaffolding approach with visual structures that may enhance knowledge communication in the managerial setting. In their study, they show how practitioners may effectively facilitate management meetings by incorporating visual representations to enhance communications in problem-solving and decision-making settings (Alexander et al., 2015). However, Alexander et al. (2015), emphasize that it is important for the practitioner to select the best visualization representation for team work and decide on which scaffold type will be the most effective to guide the meeting agenda. This framework for knowledge visualization for practitioners is presented in Figures 2.5 to 2.8.

The first level is *grounded* scaffold (Fig. 2.5) which uses facilitation diagrams that allow individuals and groups to work and collaborate with problem-solving concepts

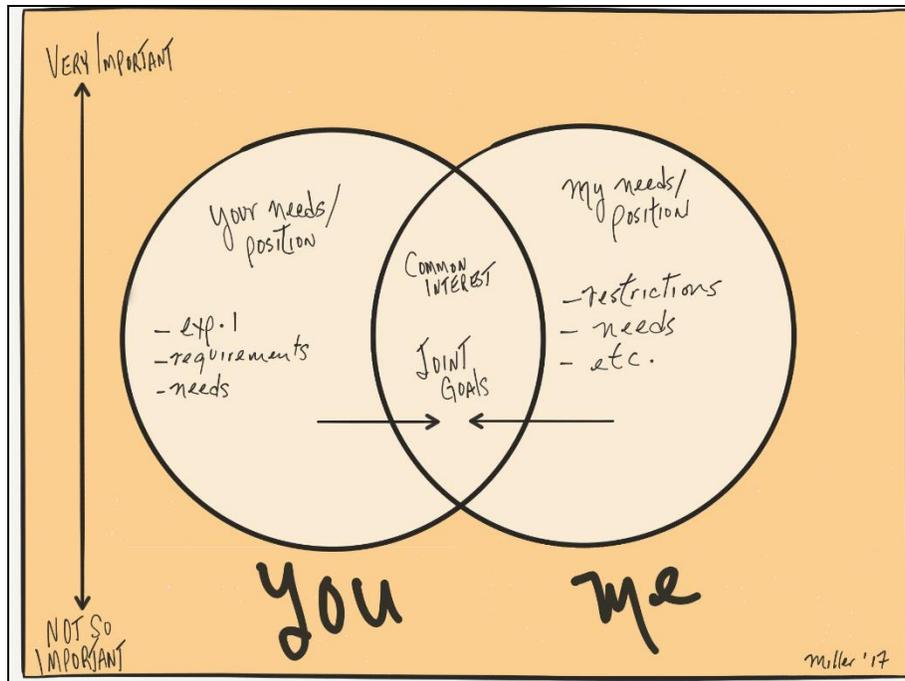
(Alexander et al. 2015). As an example, in the grounded scaffold facilitation template below, groups can enhance their collaborative efforts by grouping their knowledge through different angles and contemplate together how to enhance their problem-solving skills (Alexander et al., 2015, p.183).



Adapted from Alexander et al. (2015)

Figure 2.5. Sketch of *grounded* scaffolds for knowledge visualization – Facilitation Template

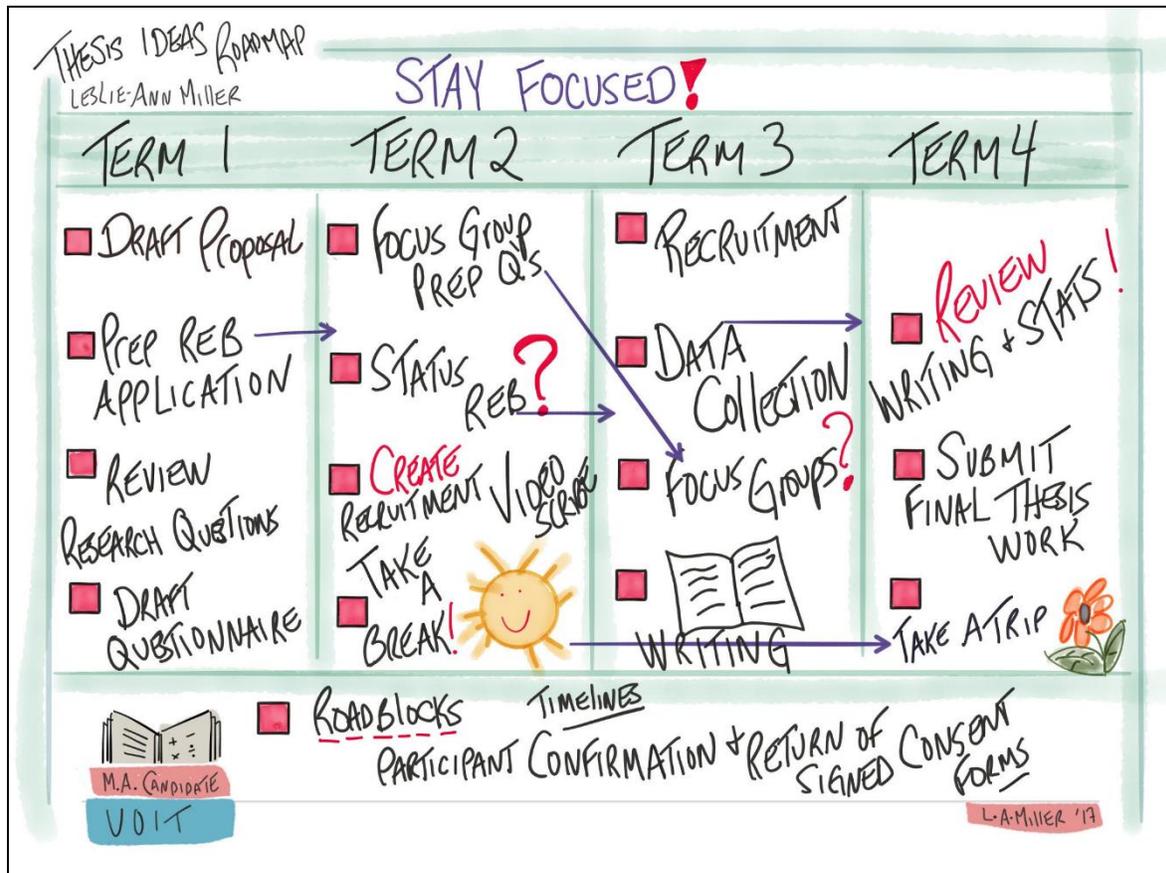
The second, *suspended* scaffold (Fig. 2.6) includes negotiation sketches which focus on Venn type diagrams that enable individuals to create a centre of interest or focus with problem-solving (Alexander et al. 2015). In this context, the suspended scaffold may be used when managers need to “work in conditions of partial ignorance” (Alexander et al., 2015, p.185). That is, in management meetings, partial ignorance could be explained as follows; “knowledge communication is characterized by exclusive and common knowledge, where the exclusive knowledge of one communication agent is the ignorance of the other communication agent in their shared context” (Alexander et al., 2015, p. 185).



Adapted from Alexander et al. (2015)

Figure 2.6. Sketch of *suspended scaffold* for knowledge visualization – Venn Diagram

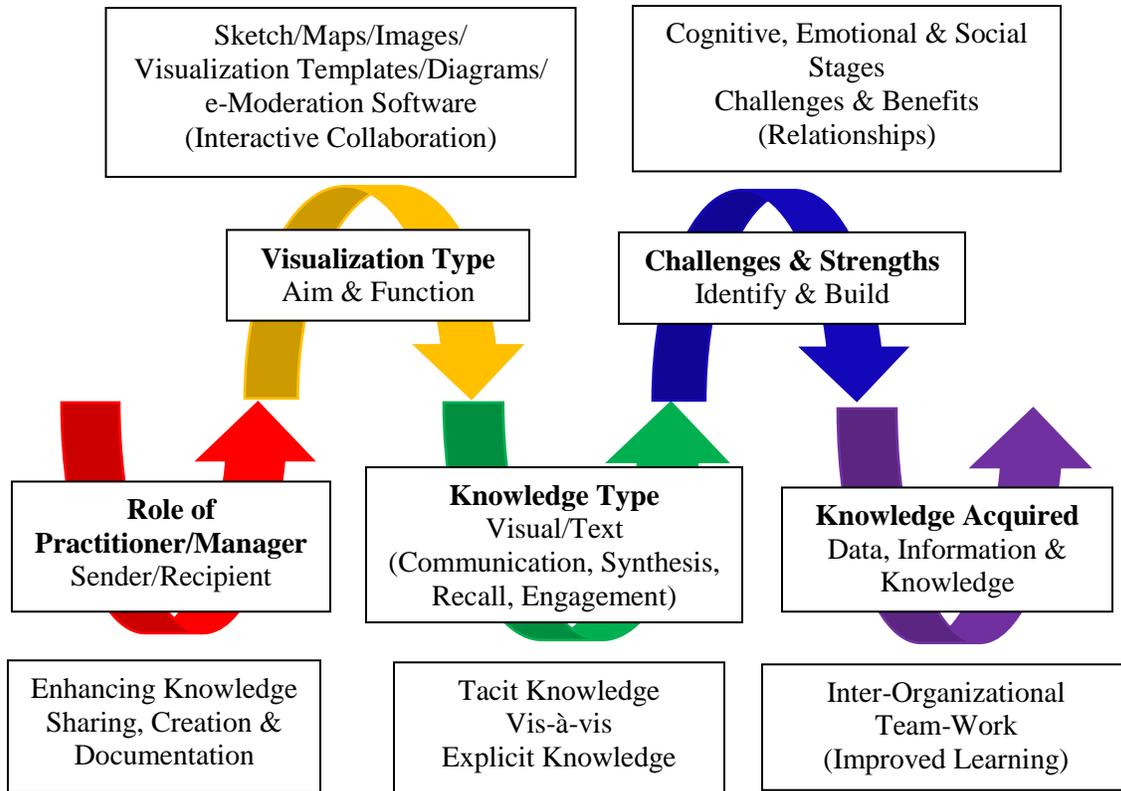
The third, *panel* scaffold (Fig. 2.7) highlights roadmaps and timeline sketch illustrations in order to visualize a work flow or a process by mapping a sequential structure and an order of doing things (Alexander et al. 2015).



(Miller, 2017)

Figure 2.7. Sketch of panel scaffolds for knowledge visualization – Roadmap

management: communication, engagement, interpretation, and challenges (Brumberger, 2007; Comi et al., 2013; Eppler & Burkhard, 2004). Each of these factors reviewed earlier in this chapter may play a key role in how managers acquire new knowledge through real-time visualization use in meetings. The development of a conceptual framework for visualization practice is presented in Figure 2.9.



(Miller, 2017)

Figure 2.9. Development of a Conceptual Framework for Visual Practice

2.9.1 Applying the Conceptual Framework to Visual Practice

The framework presented in Figure 2.9 serves to guide and orient an individual's learning (Knowles, 1980) to successfully implement visualization methods in management meetings. The researcher has proposed a five-step process in the framework to approach and

address how visualization methods can be structured for management meetings. These steps include the role of manager/practitioner, visualization type, knowledge type, challenges and strengths, and knowledge acquired.

The first step in the framework focuses on the Role of the Practitioner and the Manager, i.e., the sender and the recipient (Burkhard, 2005). The focus for both the practitioner and the manager should be to engage individuals in the meeting (Burkhard, 2005) in order to enhance knowledge sharing, knowledge creation and knowledge documentation in team-work (Alexander et al., 2015). As a result, by incorporating visualization representations in meetings for the transfer of data and information, individuals gain significant learning through knowledge sharing in management meetings (Eppler & Platts, 2009).

The second step in the framework focuses on the Visualization Type (Burkhard, 2005) that should be considered when planning and executing a visualization management meeting. In this second step, the practitioner and the lead manager of a meeting discuss together the aim and function for the visual artifact (Burkhard, 2005; Knowles, 1980). Certain considerations may focus on how a sketch, diagram or visualization templates could potentially enhance inter-organizational collaboration (Brumberger, 2007) and optimize knowledge sharing among meeting participants (Brumberger, 2007; Burkhard, 2005; Pfister & Eppler, 2012). Thereby, creating context for the design thinking stages of visualization (Degnegaard et al., 2015).

In the third step, the focus is on the Knowledge Type. This step illustrates how both the visual image and the written text format can assist individuals to enhance communication, engagement, synthesis and recall of information (Alexander et al., 2015; Brumberger, 2007; Eppler & Platts, 2009). In meetings, the practitioner and the manager will encounter tacit

knowledge, which information not easily explained, versus explicit knowledge, which information that is easily defined and articulated (Alavi & Leidner, 2001). Burkhard (2005) indirectly addresses tacit knowledge, the *know-how* vis-à-vis explicit knowledge, the *know-what* as an effective means for the creation and transfer of knowledge through this knowledge visualization framework.

In the fourth step, the focus is on cognitive, emotional and social challenges and strengths. In these stages, individuals will encounter cognitive, social and emotional challenges encountered with visualization use, and build on the benefits (Eppler & Platts, 2009). One of the cognitive challenges encountered in knowledge-intensive meetings is struggling with information overload (Eppler & Platts, 2009). Eppler & Platts (2009) theorize that a cognitive benefit of information overload in visualization could be for individuals to extract and synthesize the information presented in a visual artifact; thereby, the recipient becomes able to understand complex issues.

The fifth and final step of the framework, Knowledge Acquired, focuses on the improved learning with data and information with visualization methods. Through planning together, the practitioner and manager enable a collective decision-making process on the steps needed to successfully implement and execute visualization methods in meetings (Burkhard, 2005; Knowles, 1980). As a result, inter-organizational team-work is effectively improved and complemented through the use of visual representations (Brumberger, 2007).

2.10 Chapter Summary

This review of the literature suggests that there are many benefits that support incorporating visual practices within management meetings to enhance knowledge creation, knowledge sharing and knowledge documentation (Brumberger, 2007; Eppler & Burkhard,

2005; Pfister & Eppler, 2012). The research highlights how individuals may augment knowledge sharing in meetings by adopting and creating visual representations in various formats that include templates, e-moderation software suites and sketches that will support collaboration, creativity and innovation in team work (Brumberger, 2007; Eppler & Burkhard, 2004; Pfister & Eppler, 2012). As a result, visual communication is considered to be an important component of knowledge management for knowledge creation, knowledge sharing and knowledge acquisition (Comi et al., 2013; Brumberger, 2007; Eppler & Burkhard, 2004; Eppler & Platts, 2009; Mengis & Eppler, 2009).

The review of the literature demonstrates gaps in research about how individuals interpret and create value from the use of visualization methods in management meetings. While there are a small number of studies that target these areas, it would be prudent for the research field to consider an approach that widens the scope of research. This could include a more thorough review of the challenges that surround a manager's interpretation and perceived value of visual representations vis-à-vis the visual practitioners' method of creation and delivery of visual representations.

Several theoretical frameworks influenced this research, most notably, Alexander, Bresciani and Eppler (2015), Burkhard (2005), and Eppler and Platts (2009). The researcher of this study developed a new conceptual framework that helped to explore how visual practice for knowledge creation and knowledge sharing will benefit knowledge management in visual practice. Importantly, the research involved in this study attempts to answer the overarching research question: How does visualization affect knowledge acquisition in management meetings? Based on the review of the literature, it was hypothesized that

visualization tools and methods used in management meetings would have a positive effect on a manager's knowledge acquisition.

3 Research Methodology and Design

3.1 Chapter Overview

The previous chapter provided an overview of the review of the literature, and a conceptual framework that guided how this research study was planned and designed. This chapter reviews the overall research study methodology, and describes the data collection and data analysis that was used to collect the data to answer the research questions: evaluating the impact of real-time visualization on knowledge acquisition in management meetings. The research methodology and design chapter overview structure is presented in Figure 3.1.

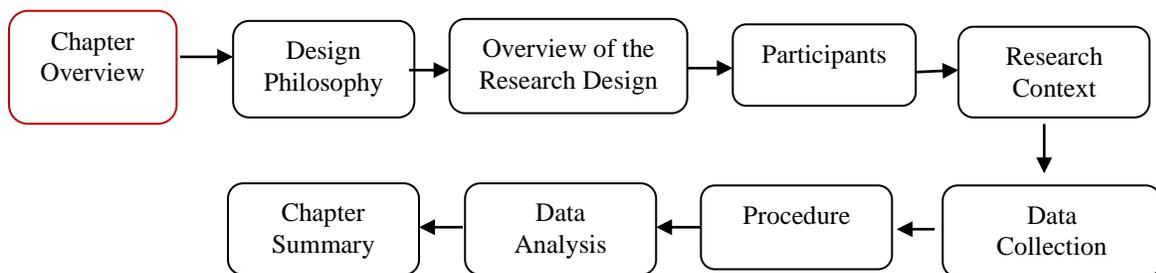


Figure 3.1. Chapter 3 Overview Structure

3.2 Design Philosophy

This research project followed a pragmatist approach to methodology (Creswell, 2014). As a pragmatist researcher, I had the freedom of choice that included various methods, techniques and research that were able to best meet my research needs (Creswell, 2014). Pragmatism is not committed to any one system of philosophy and reality, and as such, the choice to adopt a pragmatist approach offered this researcher the best overall understanding of the data in this research (Creswell, 2014). Therefore, in order to achieve a thorough and robust data collection response, the researcher adopted a mixed method approach in this research project (Creswell, 2014).

3.3 Overview of the Research Design

3.3.1 A Mixed Method Approach

The purpose of a mixed-method approach in this research project is to discover how managers' knowledge acquisition is impacted by real-time visualization in management meetings (Creswell, 2014). At this stage of the research, the real-time visualization can be generally defined as a means of formulating ideas and concepts with graphic representations of data and information, in a meaningful structured manner for enhancing the quality of collaboration (Eppler & Platts, 2009; Eppler & Bresciani, 2012).

A mixed method approach made it possible to use various different data collection and analysis methods (Creswell, 2014). Additionally, a mixed method approach offered the researcher insightful findings, which neither quantitative and qualitative methods could provide when used on their own (Creswell, 2014). Further, a mixed-methods approach provides different types of data, including limitations and strengths (Creswell, 2014). The researcher is presented with another avenue to consider how the limitations and strengths could be better understood, and therefore have a better understanding of how real-time visualization affects a manager's knowledge acquisition in management meetings (Creswell, 2014).

The data collection included an online Likert Scale survey and three focus group sessions. The survey and the focus groups were enhanced by open-ended questions. This approach in the research offered rich qualitative data on the managers' interpretation of attitudes towards the use of real-time visualization in management meetings (Creswell, 2014).

This research project supports a pragmatic approach because it sets out to address the issue of how corporate managers could augment their knowledge acquisition through the adoption of real-time visualization during the meeting facilitation process (Creswell, 2014). The overarching research question addressed in this study is: How does real-time visualization affect knowledge acquisition in management meetings? In order to address this question and measure how visualization affects knowledge acquisition, a Likert type scale survey was distributed online to participants (see Appendix E) and three separate focus group sessions followed the online survey for a select group of managers.

A letter of invitation was distributed to potential participating business leaders and all interested participants (see Appendix A). An e-newsletter announcement and attached VideoScribe link by the MEDEC organization was distributed to their membership for consideration (see Appendices B, C). An online Likert scale survey identified managers that have previously participated in real-time visualization management meetings (see Appendix E). The online survey assisted the researcher to further identify the number of times managers have participated in real-time visualization meetings. Following the online survey of the research study participants, a follow-up focus group session and interviews allowed managers to offer their views and ideas on the research topic (Creswell, 2014). The online survey also offered a quantitative analysis of results of attitudes and opinions of the corporate managers' experiential learning (Creswell, 2014; Kolb, 1984), (see Appendix E).

Data for this research included the responses to a Likert scale online survey, and hand-written and typed field notes, and visual sketchnotes. The visual sketchnotes include pre-designed graphic templates as well as digital graphic recording visual notes. The focus group sessions were conducted online. The questions presented and discussed were open-ended in

nature; the managers then elaborated on their online survey answers about how visualization affects knowledge sharing, creation and documentation in management meetings.

The quantitative data from the Likert scale survey was enhanced by additional qualitative data through the focus group sessions with open-ended questions in order to offer additional information on the managers' interpretation and attitudes towards the use of real-time visualization in management meetings.

3.4 Participants

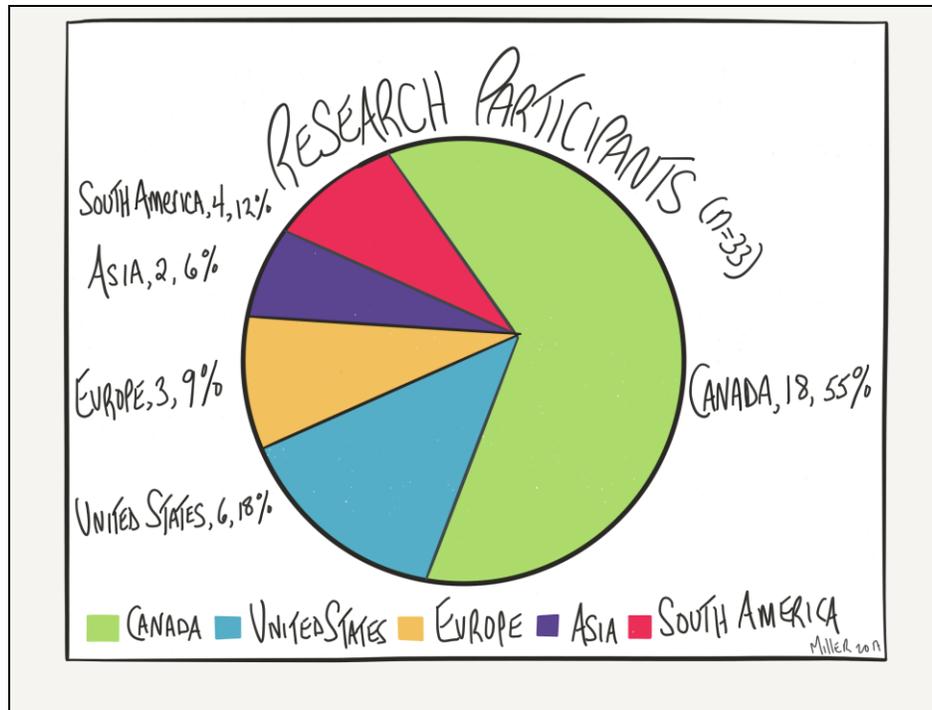
3.4.1 Recruitment of Participants

The managers were recruited through two different groups which offered the research access to a diverse field of participants that presented different perspectives on the research topic (Creswell, 2014). The first, the MEDEC group, which is a national organization that is “the primary source for advocacy, information and education on the medical technology industry for members, the greater healthcare community, industry partners and the general public” (www.medec.org, 2017). The researcher was a former member and committee chair of the MEDEC organization in 2009; however, the researcher has not had any direct affiliation since this time.

Additionally, the social media platform [*LinkedIn*](#) was a secondary choice for recruitment and provided a positive link of the social media site membership to the researcher. Additional recruitment was created through reference referrals via interested participants in both groups.

3.4.2 Description of the Research Participants

The 33 participants in this study are experienced managers with a minimum five years' managerial experience within the public and private-sector of the corporate industry. There were 23 corporate managers and 10 visual practitioner managers participating in the research. The research included the following number of years of professional experience: 6 managers had less than five years, 4 had 6-10 years' experience, 11 had 11-15 years' experience and 12 had 15 years' experience. The participants are located in 7 countries on 5 different continents around the world (see Figure 3.2). As determined from the online study questionnaire, all managers within the study will have been previously exposed to a synchronous management meeting facilitated with real-time visualization. The study identified the mix of males and females, age level, country of residence, country of origin, education level, and management experience level.



(Miller, 2017)

Figure 3.2 Research Participants Geographical Location Data

3.5 Research Context

Corporate managers from different professional specialties were invited to participate in the online survey and focus group sessions. The Likert scale online survey determined the number of managers that have been previously exposed to real-time visualization techniques in management meetings (Appendices D, E). The online survey data collection and findings identified all managers that have previously participated in a synchronous real-time visualization management meeting. The managers were invited to participate in a post-survey data collection and focus group discussions (Appendices D, E).

The research study included three focus group sessions which allowed for observations and open-ended responses. The focus group sessions were synchronous real-time meetings that included 2-3 managers per session. The researcher conducted the focus group sessions in

real-time using sketch-based templates to collect the focus group information. The focus group sessions offered open-ended questions that encouraged individual and group knowledge sharing of managers' experiences with real-time visualization meetings (Appendix F). The focus group sessions details are presented in Table 4.

Table 4. Focus Group Session calendar details

Focus Group Date	Group Type	Number of Participants	Participant Location
March 21, 2017	Business Managers	3	Canada
March 25, 2017	Business Managers	2	Canada
April 2, 2017	Business Managers	3	Canada

Specifically, the researcher addressed the following guiding questions (see Table 5) during the focus group sessions.

Table 5. Guiding Questions for Data Collection

Guiding Questions	Data Materials	Use of Data	Data Analysis Conducted
Could you describe how you would typically facilitate a traditional management meeting?	Hand-written notes/sketchnotes/ Computer for videoconference meetings	Provided in Focus Group Session, participants' own interpretation and understanding of advantages and challenges of visualization.	The Focus Group (FG) text and visual notes were analyzed for common themes and threads. Notes and observations will be compared and analyzed with the Conceptual Framework for Visual Practice (Miller, 2017).
Following your active participation in a real-time visualization meeting(s), how do you think your organizations' could benefit from incorporating visualization tools in meetings?	Hand-written notes/sketchnotes/ Computer for videoconference meetings	Provided in Focus Group Session, participants' own interpretation and understanding of advantages and challenges of visualization.	The Focus Group (FG) text and visual notes were analyzed for common themes and threads. Notes and observations will be compared and analyzed with the Conceptual Framework for Visual Practice (Miller, 2017).
How do you think a real-time visualization meeting differs from a traditional meeting?	Hand-written notes/sketchnotes/ Computer for videoconference meetings	Provided in Focus Group Session, participants' own interpretation and understanding of advantages and challenges of visualization.	The Focus Group (FG) text and visual notes were analyzed for common themes and threads. Notes and observations will be compared and analyzed with the Conceptual Framework for Visual Practice (Miller, 2017).
Please share with the group any limitations or challenges of use with facilitating real-time visualization meetings. How did you overcome the barriers?	Hand-written notes/sketchnotes/ Computer for videoconference meetings	Provided in Focus Group Session, participants' own interpretation and understanding of advantages and challenges of visualization.	The Focus Group (FG) text and visual notes were analyzed for common themes and threads. Notes and observations will be compared and analyzed with the Conceptual Framework for Visual Practice (Miller, 2017).
Please describe how you have implemented or change the manner of meeting facilitation in your organization after participating in a real-time visualization meeting. Are your meetings run more efficiently? Please explain.	Hand-written notes/sketchnotes/ Computer for videoconference meetings	Provided in Focus Group Session, participants' own interpretation and understanding of advantages and challenges of visualization.	The Focus Group (FG) text and visual notes were analyzed for common themes and threads. Notes and observations will be compared and analyzed with the Conceptual Framework for Visual Practice (Miller, 2017).
How is your comfort level with facilitating a real-time visualization meeting versus a traditional meeting? Please explain.	Hand-written notes/sketchnotes/ Computer for videoconference meetings	Provided in Focus Group Session, participants' own interpretation and understanding of advantages and challenges of visualization.	The Focus Group (FG) text and visual notes were analyzed for common themes and threads. Notes and observations will be compared and analyzed with the Conceptual Framework for Visual Practice (Miller, 2017).

The focus groups were comprised of managers that have regularly experienced the use of real-time visualization in management meetings; thus offering data information in the focus group session discussion that created a more robust interpretation of the benefits and limitations for real-time visualization in management meetings (Appendix F).

3.6 Data Collection

3.6.1. Overview

The research included four types of data: quantitative data in the form of Likert questions, qualitative open-ended questions, real-time visualization data collection of both focus group sessions and observations of group discussions (see Appendices D, E, F). The Likert questions provided a quantitative and qualitative overview of the participants' interpretation, attitudes, and overall knowledge acquisition in real-time visualization management meetings versus traditional meetings (see Appendices E, F). The open-ended questions allowed the participants to offer additional information about their learning of the value and/or limitations of real-time visualization experience (see Appendix F).

The focus group sessions allowed the participants to share knowledge information about their experience with repeated real-time visualization management meetings and how their learning impacted their knowledge acquisition and/or implementation of use in their organizations (see Appendix F). The observational data collection was collected by the researcher using hand-written, typed notes and visual note-taking techniques during the focus group sessions (see Appendix G).

The purpose of the online survey was to determine the measurable benefits of using real-time visualization in management meetings. The intent was to identify the effectiveness and or/limitations of using real-time visualization in management meetings, as well as how it is applied in practice in order to improve an organization's business efficiencies.

3.7 Procedure and Ethical Considerations

The researcher submitted a research study application to University of Ontario Institute of Technology (UOIT) Research Ethics Board (REB) and received approval on January 2, 2017, REB #14138. The application submitted to the REB included a rationale for the research, a description of the data collection materials and procedures, description of participants, and the risks and benefits. The researcher completed the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans Course on Research Ethics (TCPS2: CORE), (see Appendix R).

The researcher distributed recruitment materials via online distribution over a two-month period in order to recruit participants. The recruitment materials are located in Appendices A, B, & C. The first recruitment artifact was a brief VideoScribe animated sketch video (see Appendix C) that gave a visual description of the research focus and contact details. Potential participants contacted the researcher via email communication. The researcher forwarded to potential participants a Letter of Introduction – Request for Consent (see Appendix A) to interested participants. Written permission and consent was received from all participants in the research before the online survey link was forwarded to participants. Participation in the research study was voluntary. All participants were offered the option to withdraw from the study at any time.

3.8 Data Analysis

There were five different data sets used in the research data collection and analysis in order to achieve a range in results (Creswell, 2014): the transcripts of focus group sessions, including the observational hand-written and visual notes, and the quantitative and qualitative survey questions. Prior to the start of the data collection, the researcher developed the survey and focus group session questions in order to understand how managers are using and learning from real-time visualization in meetings.

Both qualitative and quantitative data was collected during the research study. The business managers and the visual practitioners were divided into two separate groups. Coding involved reviewing the data, organizing the qualitative data into salient themes, and developing graph charts to analyze the quantitative data. The researcher adopted a convergent mixed parallel method in order to collect the quantitative and qualitative data at the same time; following, the data was merged together to interpret the overall results (Creswell, 2014). Numeric identifiers were allocated to each participant in both groups during the analysis. The online survey was developed using Google Forms, using a secure network so that only the researcher and the Faculty supervisor had access to the response file. The survey responses were downloaded to an Excel file and securely stored on a password protected flash drive that was only accessed by the researcher.

Data from the online survey was transferred and recorded in Microsoft Excel 2016 to evaluate the different responses from the participants. The researcher also noted the observations that were reported in the focus group sessions to establish common themes and relationships with responses from the online survey. The purpose of the research was clearly outlined and shared with the researchers' Masters' thesis supervisor and the individual

participants within this research. The researcher did not receive any compensation or benefits in regards to this research project.

3.9 Chapter Summary

The online Likert Scale survey and focus group sessions were developed and organized to answer the overarching question: How does real-time visualization impact knowledge acquisition in management meetings? To explore this question within the research, the researcher recruited experienced corporate managers and visual practitioners for this research project. Participants were directed to the online Google forms survey to respond to the quantitative and open-ended questions. The participants were asked in the online survey about their interest in joining a focus group session to discuss and share their thoughts and views on real-time visualization use in management meetings.

4 Results

4.1 Chapter Overview

Chapter 3 provided an overview of the research methodology and design and justification for the mixed-method approach in this research. This chapter illustrates the results of a small group of experienced managers and practitioners, in order to explore the research topic: what is the impact of real-time visualization on knowledge acquisition in management meetings? The results will be categorized by each of the research questions. The research results chapter overview structure is presented in Figure 4.1.

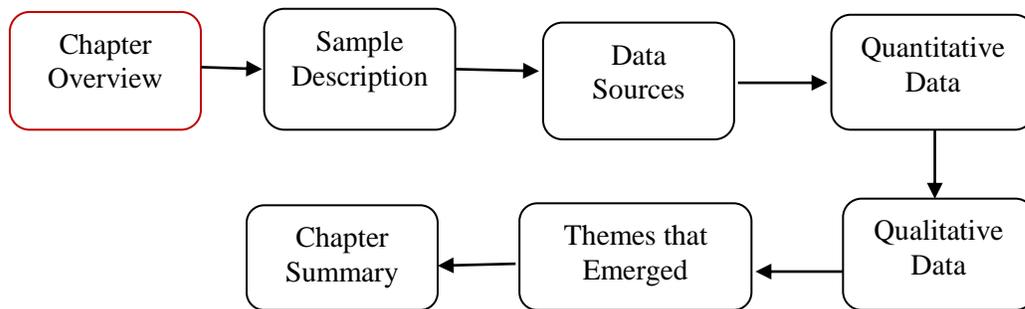


Figure 4.1. Chapter 4 Results Overview Structure

4.2 Sample Description

The participants (n=33) were experienced managers, comprised of corporate managers (n=23) and visual practitioners (n=10). The focus group sessions comprised of 8 managers. Although the researchers' goal was to have more focus groups sessions, the time allotted for data collection was not sufficient enough in order to schedule properly around the managers' busy international travel schedules. Different time zones also created obstacles for organizing the focus groups sessions.

While age was not a specific question in the survey, the researcher opted for a question to determine a range in age stemming from decade born as follows: 1950 (33.3%), 1960 (27.3%), 1970 (27.3%), and 1980 (12.1%). The gender is predominantly female (57.6% females, and 42.4% males). The education level was post-secondary across the sample as follows: College (12.1%), Undergraduate degree (36.4%), Masters degree (45.5%) and Doctorate degree (6%). The managers' number of years of professional experience was predominantly high, with 69.7% having 11 or more years' experience. The grouping is as follows: less than 5 years (18.1%), 6-10 years (12.1%), 11-15 years (33.3%) and 15 or more years' professional experience (36.4%). The sample exhibits high international diversity, with 11 different nationalities spread across 5 continents.

4.3 Data Sources

The data for this research was collected using three areas that included, an online Likert Scale survey, with four open-ended questions (see Appendices D, E). The questions produced both quantitative and qualitative data. The results of the analysis of the data of all participants is presented. The third area for data collection was three online focus group sessions that reviewed six open-ended questions (see Appendix F).

4.4 Quantitative Data

The results of the research were analyzed by first conducting a frequency analysis that included the median score (Mdn), mode score (M) and the interquartile range (IQR) of 10 measures (see Appendices O, P). Following, the results of the frequency analysis are reported in clustered bar charts (see Appendices H, I, J, K, L, M, N). The researcher also did a comparison of the corporate manager vis-à-vis the visual practitioner to further understand

how each group interpreted and responded to the research questions. These findings are reported here in chapter 4 and discussed in detail in chapter 5, *Discussion*.

4.4.1 Responses to Research Question 1

The reported results show that research question 1, “How does visualization affect knowledge acquisition in management meetings?” is supported by the data: 84.8% of participants’ knowledge acquisition is affected by real-time visualization in management meetings. The results indicate that most of the respondents found knowledge acquisition was more effective or excellent (Mdn=4, IQR=1.5) (see Appendix O). Seventy-five point eight percent (75.8%) of participants report that knowledge acquisition was more effective or excellent compared to 9% who reported it as poor or less effective. Fifteen point two percent (15.2%) of respondents found no difference in knowledge acquisition.

When comparing the two groups, the corporate manager and the practitioner, the results indicate significant differences in this area of knowledge acquisition. Sixty-five point two percent (65.2%) of corporate managers report that knowledge acquisition is more effective or excellent, whereas, 40% of the practitioners’ report that knowledge acquisition is more effective and 60% report knowledge acquisition as excellent. Twenty-one point seven percent (21.7%) of corporate managers report no difference in knowledge acquisition and 13% report it as less effective or poor.

Knowledge Sharing. The results report that knowledge sharing is more effective or excellent (Mdn=4, IQR=1) (see Appendix O). Eighty-four point eight percent (84.8%) of participants report that knowledge sharing was more effective or excellent compared to 6.1% who report it as poor or less effective. Nine point one percent (9.1%) found no difference in knowledge sharing.

When comparing the two groups, the corporate manager and the practitioner, the results indicate significant differences in this area. Seventy-eight point three percent (78.3%) of corporate managers report that knowledge sharing was more effective or excellent compared to 100% of practitioners who reported it as more effective or excellent. Thirteen percent (13%) of the corporate managers found no difference in knowledge sharing and 8.7% found knowledge sharing to be less effective.

4.4.2 Responses to Research Question 2

The reported results show that research question 2, “What are the advantages of visualization in management meetings?”, is supported by the data in the areas of engagement, knowledge sharing, knowledge acquisition and the return on investment/value. The results for knowledge sharing and knowledge acquisition are reported in section 4.4.1.

Engagement. The results indicate that 78.8% of all participants report that engagement in management meetings were more effective (Mdn=4, IQR=1) (see Appendix O). Seventy-eight point eight percent (78.8%) of participants found engagement was more effective or excellent as compared to 9% who report it as less effective or poor. Twelve point one percent (12.1%) of participants reported no difference in engagement of meeting participants. When comparing the two groups, the corporate manager and the practitioner, 69.6% of corporate managers report that engagement in meetings was more effective or excellent, whereas 100% of practitioners found that engagement was more effective or excellent. Seventeen point four percent (17.4%) of the corporate managers report no difference of meeting engagement and 13% report engagement to be less effective.

Return on Investment(ROI)/Value. The results indicate that most of the respondents found the return on investment and value received by incorporating visualization methods in

management meetings was medium to high (Mdn=3, IQR=1) (see Appendix P). Eighty-one point eight percent (81.8%) of all participants report that the return on investment and value of using real-time visualization methods in management meetings was medium to high. Twelve point one percent (12.1%) of all participants report a low interest and 6.1% report no interest on the return on investment and value of visualization methods. When comparing the two groups, the corporate manager and the practitioner, 73.9% of corporate managers reported a medium to high ROI/Value, whereas 100% of practitioners report a medium to high ROI/Value of visualization use in management meetings. Seventeen point four percent (17.4%) of the corporate managers report a low ROI/Value and 8.7% report not interested.

4.4.3 Responses to Research Question 3

The reported results show that research question 3, “What are the disadvantages of visualization in management meetings?” is reflected in the reported data in the areas of knowledge acquisition, knowledge sharing, meeting flow, and ease of use. The data for knowledge sharing and knowledge acquisition is reported in detail in section 4.4.1. The detailed data for meeting flow and ease of use is reported in the following section, 4.4.4, *Research Question 4*. Certain significant report details are noted here for review.

The data results indicate that 21.7% of corporate managers report no difference in knowledge acquisition and 13% report it as less effective or poor. In the area of knowledge sharing, 13% of the corporate managers found no difference in knowledge sharing and 8.7% found knowledge sharing to be less effective. In the area of engagement in management meetings, 17.4% of the corporate managers report no difference of meeting engagement and 13% report engagement to be less effective. In the area of meeting flow, 43.4% of the corporate managers found no difference in meeting flow and 13% report that the meeting flow

was less effective. Finally, in the area of ease of use of visualization methods, 56.5% of the corporate managers reported that there was no difference in the ease of use of visualization methods from traditional meeting methods.

4.4.4. Responses to Research Question 4

The reported results show that research question 4, “What are the attitudes of managers towards the use of visualization in management meetings?”, is reflected in the reported data in the areas of meeting flow, ease of use, interest to work, apply and learn visualization methods.

Meeting Flow. The results indicate that most of the respondents found their meetings were more effective (Mdn = 4, IQR=1) (see Appendix O). Fifty-five point six percent (55.6%) of participants found visualization methods in meetings more effective or excellent as compared to 9% who found it less effective or poor. Thirty point three percent (30.3%) of participants reported no difference in the meeting flow. When comparing the two groups, the corporate manager and the practitioner, 43.5% of corporate managers report that the meeting flow was more effective or excellent compared to a 100% of practitioners who report the meeting flow to be more effective or excellent. Forty-three point four percent (43.4%) of the corporate managers found no difference in meeting flow and 13% report that the meeting flow was less effective.

Ease of Use. The results indicate that most of the respondents found visualization methods ease of use to be of effective value (Mdn=4, IQR=2) (see Appendix O). Forty-three point five percent (43.5%) of corporate managers report that the ease of use of visualization methods are more effective or high, whereas 90% of practitioners’ report ease of use as more effective or excellent. The data reports that 56.5% of the corporate managers found no difference in the ease of use of visualization methods.

Interest to Work with Visualization Methods. The results indicate that most of the respondents report an interest to work with visualization methods (Mdn=3, IQR=1) (see Appendix P). Forty-two point four percent (42.4%) of all participants' report a medium interest to work with visualization methods and 48.4% report a high interest. The data indicates that 6.1% of participants report a low interest to work with visualization methods and 3.3% report that they are not interested. When comparing the two groups, the corporate manager and the practitioner, 91.4% of corporate managers report a medium to high interest to work with visualization methods, which is an almost even comparison to the 20% of practitioners that report a medium interest and 70% of practitioners report a high interest to work with visualization methods.

Interest to apply visualization methods. The results indicate that most of the respondents report an interest to apply visualization methods in management meetings (Mdn=4, IQR=1) (see Appendix P). Thirty-three point three percent (33.3%) of all participants report a medium interest to apply visualization methods in management meetings, and 57.6% of all participants report a high interest. The data indicates also that 6.1% have a low interest and 3.1% report not interested to apply visualization methods. When comparing the two groups, the corporate manager and the practitioner, 86.8% of corporate managers report a medium to high interest to apply visualization methods and 100% of practitioners report a medium to high interest. Eight point seven percent (8.7%) of the corporate managers report a low interest and 4.4% report not interested.

4.5 Qualitative Data

The managers were asked the following open-ended questions in the online Likert Scale survey (see Table 6). The researcher reports a categorized coding scheme (see Tables 8-11)

that briefly summarizes the open-ended questions by each research question and research theme.

Table 6. Open-ended online survey questions

<ol style="list-style-type: none">1. Could you describe how you would typically facilitate a traditional management meeting?2. How do you think a real-time visualization meeting differs from a traditional meeting? Please explain.3. Following your active participation in a real-time visualization meeting(s), how do you think your organization could benefit from incorporating visualization tools in meetings?4. Have you found any limitation(s) from incorporating visualization tools in meetings?

4.5.1 Focus Group Results

The focus group questions were linked to four key themes; communication, performance, interpretation and challenges. The researcher reports here the focus group questions (see Table 6) and summarizes the results. The focus group participants were asked to discuss briefly their roles within their organizations and also to share with the group how they typically facilitate a traditional management meeting. The participants equally reported that a traditional meeting would include: fixed agenda items, topic agenda items, a Chair, agenda review, keeping people on task and a report of minutes of the meeting. They also reported that the focus of a traditional meeting is set around brainstorming ideas and building content on a chosen topic.

The participants were asked: “Following your active participation in a real-time visualization meeting(s), how do you think your organizations could benefit from incorporating visualization tools in meetings?” The participants reported that if an organization could incorporate whiteboard walls in their offices as a start to including

visualization tools in meetings, this would encourage individuals to engage more and demonstrate ideas in a visual manner. The participants further report that this approach offered individuals the option to share their thoughts and ideas throughout a project planning process. The participants reported that this approach would be effective to build content during discussions and each individuals' contribution could be seen and discussed during a meeting, thereby, augmenting knowledge sharing and knowledge acquisition of individuals.

According to the participants, the visual display of information on a whiteboard wall offers team members the ability to consider the textual and imagery display as a visual template of ideas, and therefore creates a more comforting way to express their thoughts in a non-judgemental manner. Finally, the focus group participants observed an additional benefit of creating whiteboard walls of text and imagery for ideas in meetings, offers individuals and organizations the ability to take photos with their smartphones and share the visual templates across their organizations.

The question of: "Please describe how you have implemented or change the manner of meeting facilitation in your organization?" was developed to shed further light on team-work processes and to clarify how an organization is sharing information across different channels. The participants reported that by incorporating whiteboard walls and visual templates in their meetings, it creates an effective way to help people understand the key messages that are conveyed by a meeting facilitator and also encourages increased engagement, including retention and recall of information in follow-up meetings. Additionally, the participants discussed how a visual template remains static during a meeting, and therefore it can provide a tangible reference to guidelines and information for the meeting and an easy reference for meeting participants post-meeting. The focus group reported that visualization methods

encourage people to come together, plan and create new project ideas and increases interactivity in team-work. At the same time, the participants noted that they were not familiar with the different ways of sharing visual templates across their organizations and they would benefit from further instruction on this area.

The groups further reported that visualization methods can complement traditional meeting formats and enhance information outputs and improve an individuals' learning. A final note of the groups discussion in this area is in regards to how the participants viewed visual templates and facilitation with visual templates as an additional benefit that could enhance conflict resolution in human resources meetings. The participants reported that through the use of visual templates and visual aids, meeting facilitators are encouraging input from all meeting participants and thus creating a tangible aid within the meeting that helps individuals visualize all the information discussed and shared in the meeting.

In regards to the disadvantages of visualization use in meetings, the researcher asked the question: "Please share with the group any limitations or challenges of use with facilitating real-time visualization meetings?" The participants consistently indicated that a lack of knowledge for understanding and interpreting how real-time visualization is introduced and used in meetings as a main point of conflict in their organizations. They further reported that additional training was necessary to understand how to facilitate remote meetings using real-time visualization methods. Further to this, the participants reported that since they were not savvy with a digital tool, they would usually revert back to PowerPoint as a means of facilitating meeting agenda items.

The groups repeatedly mentioned that visual artifacts and creating visuals in real-time was a distraction to the meeting as a whole. The participants reported that there is concern that valuable meeting time lead-up time to meetings would be lost if they were tasked to incorporate real-time visualization methods without proper training and lead time. However, while the participants mentioned concerns surrounding lack of training of visualization methods, they also noted that with skilled training, an organization could successfully implement visual techniques in meetings, including remote meetings. Finally, the participants reported that they do not understand the function and differences between a Graphic Facilitator and a Graphic Recorder in meetings and asked how do each of these specialties differ from a regular meeting facilitator.

Table 7. Open-ended online Focus Group questions

1. Could you describe how you would typically facilitate a 'traditional' management meeting?
2. Following your active participation in a real-time visualization meeting(s), how do you think your organizations could benefit from incorporating visualization tools in meetings?
3. How do you think a real-time visualization meeting differs from a 'traditional' meeting?
4. Please share with the group any limitations or challenges of use with facilitating real-time visualization meetings? How did you overcome the barriers?
5. Please describe how you have implemented or change the manner of meeting facilitation in your organization after participating in a real-time visualization meeting? Are your meetings run more efficiently? Please explain.
6. How is your comfort level with facilitating a real-time visualization meeting versus a 'traditional' meeting? Please explain.

4.5.2 Themes that Emerged

The researcher developed a coding scheme for categorizing the different themes that emerged from the data sources. The four key themes are communication, interpretation, performance and challenges, and will be discussed in further detail in chapter 5, *Discussion*. The coding scheme for categorizing the research themes for knowledge management is presented by each research question in Tables 8-11.

4.5.3 Coding Scheme for Categorizing Knowledge Management

Table 8. Coding Scheme for Categorizing Knowledge Management – Research Question 1

How does visualization affect knowledge acquisition in management meetings?

M = Manager P = Practitioner

Theme	Supporting Comment
Communication	M: "It can allow for visualization of the idea's and concepts that are developed in the meeting and lead greater collaboration and creativity." P: "Increase the quality of the discussion because people are incentivized to speak up if they see critical information missing on the charts or if they have a point of contention."
Performance	M: "For some learners, a visual is a key to better understanding an idea or retaining the learning." P: "Data retention of the meeting is increased, deeper understanding, more engagement, focused dialog."
Interpretation	M: "The visual cues must help participants figure out the connections between concepts and be very effective at capturing complexity." P: "Visual meetings help create an effective meeting because everyone's contribution is visually recorded and thus recognized and respected. "
Challenges	M: "Some times people could get distracted with the visuals and not pay attention to whoever is speaking." P: "Visual participants may have a more difficult time seeing the visual artifact and getting their contributions included."

Table 9. Coding Scheme for Categorizing Knowledge Management – Research Question 2

What are the advantages of visualization in management meetings?

M = Manager P = Practitioner

Theme	Supporting Comment
Communication	M: “It could develop a template for when it would benefit teams to use visualization.” P: “Artifacts created during the meeting help keep people engaged and focused on the topic under discussion because they can see a synthesis of the key points in the conversation in real time.”
Performance	M: “Making the capture transparent, in real-time allows for the group to make amendments or clarifications of what is captured, in addition to having real-time reflection to support their work in the moment.” P: “Visualization offers visual support to a discussion, making sure all contributions are heard, recognized, and integrated into a process.”
Interpretation	M: “The biggest advantage is being able to see thoughts and ideas come to life in visuals, versus words.” P: “Visualization removes several barriers that are commonly present in a traditional meeting.”
Challenges	N/A

Table 10. Coding Scheme for Categorizing Knowledge Management – Research Question 3

What are the disadvantages of visualization in management meetings?

M = Manager P = Practitioner

Theme	Supporting Comment
Communication	M: “In remote meetings, technology is lacking on our end and on the receiving end.” P: “It can be more challenging to have virtual attendees if the client wants to work visually on large charts of paper in the room.”
Performance	M: “May be a bit of a distraction, to those who have not experienced it before.” P: “Resources both cost and talent.”
Interpretation	M: “Sometimes when the discussion is too complex or there are too many different goals being pursued.” P: “Preparation and sometimes some people take offence at characterizations (icons).”
Challenges	M: “Comfort level of the customer and the audience are mostly the limiting factor.” P: “The greater challenge in introducing this way of working to a group that is unfamiliar, there is often resistance to changing the familiar way of working for something new.”

Table 11. Coding Scheme for Categorizing Knowledge Management – Research Question 4

What are the attitudes of managers towards the use of visualization in management meetings?

M = Manager P = Practitioner

Theme	Supporting Comment
Communication	M: “The tracking of information as it is created and discussed creates a collective reflection, rather than relying on one individual (for example) who is taking notes for the meeting etc.” P: “A lot more clarity, stronger documentation, enhanced follow-up, better mindshare.”
Performance	M: “Participants are more engaged and more creative in problem solving.” P: “The visual cues help participants figure out the connections between concepts and be very effective at capturing complexity.”
Interpretation	M: “When it's done by a skilled graphic facilitator, it seems most useful for brainstorming meetings, convening participants to get their insight into a particular topic, or carrying out the kick-off of a new project or initiative.” P: “Greater buy-in and understanding of what was discussed and how decisions were made in the meeting for both participants and those that were unable to attend the meeting.”
Challenges	M: “In remote meetings, technology.” P: “What to do with the chart after its usefulness has passed.”

4.6 Chapter Summary

In this chapter, the researcher has compiled both quantitative and qualitative data results that explored the impact of real-time visualization on knowledge acquisition in management meetings. The major goal of this research was to evaluate the impact of real-time visualization on knowledge acquisition in management meetings. The results were presented in the format of frequency analysis tables and clustered bar charts, and then linked to the research questions and the themes that emerged from the research. The Focus Group session participant’s results are reported. The results of the research findings will be discussed in detail in chapter 5, *Discussion*.

5 Discussion

5.1 Chapter Overview

The purpose of this research was to evaluate the impact of real-time visualization on knowledge acquisition in management meetings. This research evaluated how managers gain knowledge and interpret how visualization methods are used in management meetings. The research studied both the corporate manager and the visual practitioner manager by evaluating both groups' viewpoints of how communication, performance levels, interpretation and challenges impact knowledge acquisition. This chapter will discuss the findings of the research, and will refer to both the literature and the research questions in order to address how visualization impacts knowledge acquisition. Finally, the limitations of the research will be addressed and key areas of future research will be highlighted. This chapter's overview structure is presented in Figure 5.1.

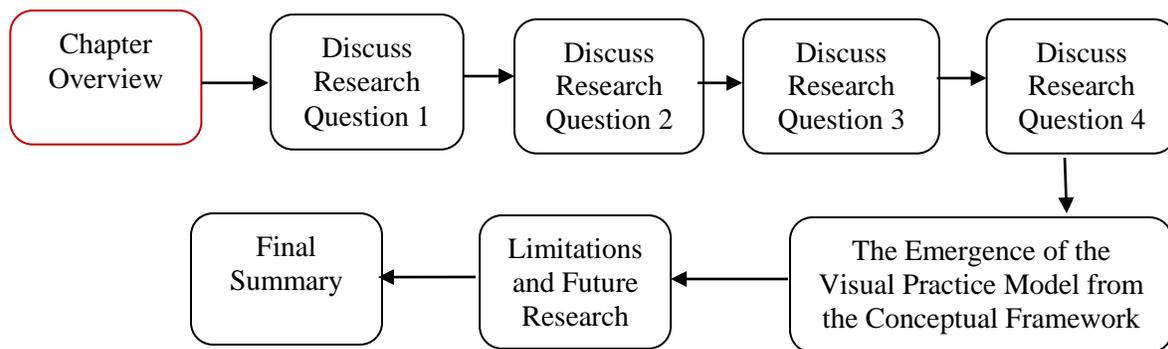


Figure 5.1. Chapter 5 Overview Structure

5.2 Discuss Research Question 1

The first research question was: How does visualization impact knowledge acquisition in management meetings? The research project explored managers' knowledge acquisition through visualization methods.

The participants reported different means of understanding how visualization methods impact knowledge acquisition, which lead to certain observations, learning and attitudes. In the research, the managers reported that knowledge sharing through conversation is an important means of information transfer in their organizations. The managers further identified that visualization tools and methods positively impact knowledge sharing. Consequently, by enhancing conversation through visualization methods in meetings, the managers also stated that visualization could offer an important means of conveying how employees learn, share, and communicate information in a more productive and collaborative manner (Mengis & Eppler, 2005; Brumberger, 2007). This finding provides some indication that managers could consider building productive strategic conversations with visualization methods in a way that would enhance the sharing of information across channels of their organizations (Mengis & Eppler, 2005), thereby supporting inter-organizational development and team-work (Comi et al., 2013). This is further supported by Mengis and Eppler (2005) who claim that visualization methods used in management meetings offer individuals the ability to change conversational behaviour.

The process of managers learning how visualization impacts knowledge acquisition also demonstrates the adult learning principle of experiential learning (Knowles, 1980; Kolb, 1984) as identified in Chapter 2, Review of the Literature. This theory is applicable to visualization use, in the way that managers describe the process to learn new knowledge with new visualization techniques and apply these new techniques to their meetings. It also reinforces the recommendation by Cummings (2003), that “knowledge sharing is seen as occurring through a dynamic learning process” (p. 3) and is further supported by Brumberger

(2007), who describes how individuals that are not experienced in visual communication could learn to make connections with ideas for problem-solving techniques in group work.

Most respondents in the online survey described communication, specifically, the impact of inter-organizational knowledge sharing as critical to their organization's success. They further described how having access to a range of visual presentation tools and more guidance on when visualization tools versus static sharing tools would be appropriate to the success of knowledge sharing in team-work. It was generally observed that participants had a high interest in learning and applying new visualization methods in order to enhance communications. Some of the participants expressed that knowledge transfer with visualization methods should be shared in an organized and easily disseminated manner for future reference (Eppler & Burkhard, 2007). This finding would support Pfister and Eppler (2012), who note that visualization can improve communication and collaboration in teams because it allows team members to simultaneously share ideas visually. It is also further supported by Burkhard and Eppler (2007), who claim that knowledge visualization has the potential to enhance knowledge creation in team-work, thereby augmenting innovation, which the participants noted is a crucial to accelerate growth in companies.

Given these findings, it could be suggested that knowledge sharing with visualization methods improves knowledge management in several areas including: "personal, interpersonal, team, organizational, inter-organizational, and societal" (Eppler & Burkhard, 2007, p.112). In contrast, the corporate managers also described how they have experienced visualization methods that hinder knowledge transfer in meetings. The researcher will discuss this finding further in section 5.4.

Most corporate managers questioned the effectiveness of the visual practitioner in meeting facilitation. This finding in the research points to a lack of understanding on the part of the corporate manager regarding how multi-complex issues discussed in meetings are shared by the visual practitioner. The corporate managers reported that knowledge sharing was successfully evident on the day of meeting with a visual practitioner; however, the short and long-term memory recall post-meeting was a point of disconnect when discussing the long term value of visualization. In contrast, the visual practitioners report that visual representations that are created in real-time provide meeting participants a record to reflect on during and after the meeting. They further report that visual charts help meeting participants explain the decisions that were made during the meeting and also provide documentation to help non-attendees understand the processes that were used in the decision-making process in the meeting.

These findings provide some indication of how the experiential learning model developed by Kolb (1984) (see 2 Review of the Literature) could offer some guidance to both managers and visual practitioners to understand how a number of factors can influence learning, and therefore should be considered when incorporating visualization methods in meetings. Also, in knowledge sharing situations, the manager may also prefer to choose certain parts of Kolb's (1984) experiential learning model to manage their own learning and "choose which set of learning abilities he or she will use in a specific learning situation" (Kolb, Boyatzis & Mainemelis, 1999, p.3). Thereby, creating a learning environment in visualization meetings allows for a better understanding of how visualization methods are effective for knowledge sharing for all participants.

Finally, to ensure successful knowledge sharing in meetings, Alexander et al. (2015) emphasize in their framework for practitioners (see 2, Review of the Literature) that it is important for the practitioner to select the best visual representation for team work and decide on which scaffold type will be the most effective to guide a meeting agenda. This finding is further supported by Burkhard (2005) who claims that the facilitator should understand the background of the meeting participants in order to choose the best visualization method for knowledge sharing. In conclusion, the data demonstrated that visualization impacts knowledge acquisition in management meetings by conveying a visual representation of employees' ideas.

5.3 Discuss Research Question 2

The second research question was: What are the advantages of visualization in management meetings? The research findings also provided context surrounding how visualization methods support learning and knowledge acquisition in management meetings. In reflecting how a real-time visualization meeting could offer different ways to increase knowledge acquisition, it was identified that visualization methods could potentially allow for new techniques that encourage visualization of ideas and concepts that are developed in the meeting leading to greater collaboration and creativity in team-work.

Most respondents indicated that visualization methods increase participant engagement in meetings. The participants further reported that by incorporating visualization methods in meetings, participants were able to jointly create a transparent record of the discussion, thereby offering opportunity to participants to make amendments and changes of the collective decision-making process during the meeting. Likewise, Degenaar et al. (2015) found that visualization enables groups to work with complex decision-making situations in

order to discuss and create decisions in a collaborative manner. This finding also supports Pfister and Eppler's (2012) claim that visual representations that are introduced in management meetings could serve as a shared focus of attention for managers and make group collaboration a continuous on-going process, and therefore increase engagement and collaborative team-work.

Most of the respondents found a high return on investment (ROI) and an increased value for their organizations by incorporating visualization methods in management meetings. The participants further reported that by incorporating visualization methods in meetings, information becomes much more clear and interesting, engagement is increased and collaborative efforts within team-work are improved. This finding is further supported by the framework for knowledge visualization developed by Burkhard (2005) (see 2 Review of the Literature), in which he describes how visualization methods and artifacts can offer an effective synergy of co-creation and transfer of information to improve learning. Eppler et al. (2011) also point out that visual artifacts have the ability to change team-work and improved innovation in meetings.

The research findings also provided a clear indication that managers view visualization tools and methods as an increased value to their organizations in the following areas: engagement, knowledge sharing, knowledge acquisition, knowledge creation, and performance levels. Despite some of the limitations and challenges of visualization methods (see section 5.4, Discuss Research Question 3), most managers reported a high interest in learning, working and applying visualization methods in management meetings.

The managers report that the structure of a conversation in meetings is an important factor when teams are working to generate multiple solutions in problem-solving scenarios.

The managers further indicated that visualization methods create additional value by structuring clarity of multiple discussion points during conversational group settings. Therefore, the value of visualization methods increase engagement within inter-organizational team work. Additionally, the participants reported that visualization increases meeting participation, immediate feedback and does not allow the meeting participants to drift away or get as distracted as much as traditional meetings. This finding is supported by Brumberger (2007) who claims that the process of incorporating sketching as a mode of designing in management meetings could offer effective problem-solving and decision-making. Comi et al. (2013) further report that visualization methods could contribute actively to shape the co-creation of information and augment performance levels of meeting participants.

Finally, the managers report that a key value and return on investment for incorporating visualization methods in management meetings is the choice of a skilled visual practitioner. The managers indicated that this individual will have the ability to ensure an ease of meeting flow and understanding of how to share multi-complex discussion points with visualization tools. This finding is supported by the knowledge visualization framework developed by Burkhard (2005) (see 2, Review of the Literature) that identifies stages that a practitioner should consider when creating visual artifacts for knowledge transfer in group-work.

5.4 Discuss Research Question 3

The third research question was: What are the disadvantages of visualization in management meetings? More than half of the corporate managers indicated that the meeting flow was less effective or poor in comparison to a traditional meeting. While this is reported as an interpretation of the corporate managers (see section 5.5.), it was also reported as a disadvantage to the meeting process. The corporate managers noted when the meeting

discussions are too complex or there are too many different goals being pursued, it is difficult to incorporate several topics in visualization meetings. As an example, the managers report that by reviewing multiple different goals within a strategic planning session, it can be difficult to follow the patterns of thoughts with visualization. However, the managers indicated that if it was one specific area of discussion, visualization would be ideal. In contrast, the visual practitioners report how visualization can create an immediate synthesis of the discussion points in a meeting and an easier recall of information, thereby helping meeting participants to stay engaged and focused on the meeting topic. Bresciani and Eppler (2009) support this claim and note that the recall of information is optimal when visualization methods are introduced in meetings. Comi et al. (2011) further support the claim by the visual practitioner and note that by working with visual artifacts, it enables individuals to understand the shared information and provides a structured template for sharing the information within team-work.

These findings support the strategizing challenges and strengths of the visualization framework developed by Eppler and Platts (2009), which indicates that one of the challenges of visualization is information overload. Eppler and Platts (2009) further suggest that some cognitive challenges of visualization include “information overload, being stuck in old view points, and biased comparisons and evaluations” (p. 44). However, in support of the findings of the visual practitioners, Eppler and Platts (2009) claim that there are strengths within visualization methods. These strengths can offer significant cognitive benefits through a synthesis of information, enabling new perspectives of individuals and also an easier recall and sequencing of information discussed (Eppler & Platts, 2009).

The visual practitioners also noted that one of the greatest challenges for a corporate manager is the introduction of working with new visualization methods. The practitioners also indicated how the managers are resistant to changing the familiar way of working in a traditional meeting setting. In contrast, the corporate managers report that their greatest challenge is incorporating visualization methods with digital tools to enhance the meeting for remote connections.

In conclusion, the data demonstrated that the corporate manager is encouraged to use new visualization techniques in meetings; however, the managers indicated an interest to learn how to incorporate visualization methods with digital tools in order to enhance the remote meeting experience for their organizations.

5.5 Discuss Research Question 4

The fourth research question was: What are the attitudes of managers towards the use of visualization in management meetings? Most respondents indicated that meeting flow in management meetings was more effective or excellent. Interestingly, when comparing the two groups, the corporate manager and the visual practitioner, almost half of the corporate managers found no difference in the meeting flow. This finding could be attributed to the fact that the corporate managers reported that they found the inclusion of visualization methods in meetings disruptive to the meeting flow. The corporate managers also indicated that meeting participants tend to be disengaged from the meeting facilitator as they are more fixed on solely looking at the evolving visual artifact. Also, the managers reported that if multiple topics are discussed in the meeting, then it could be difficult to follow the patterns of thoughts.

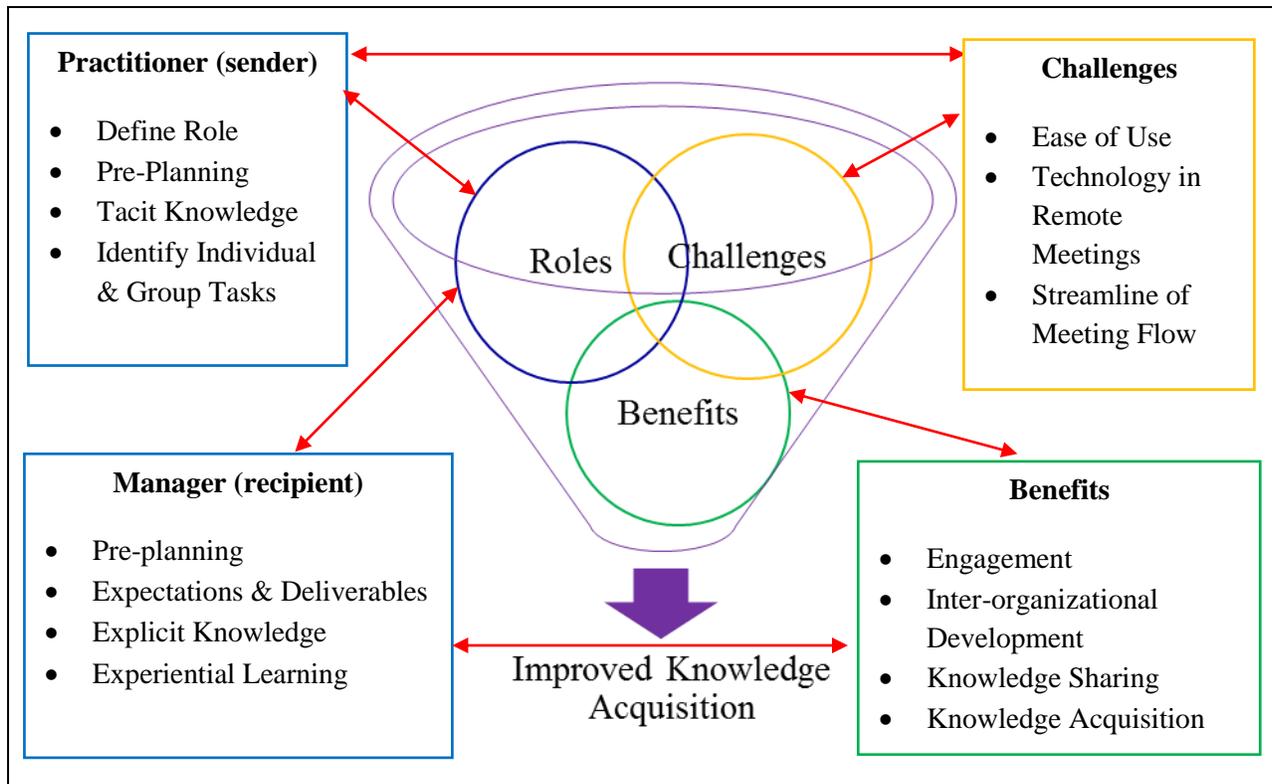
In contrast, the visual practitioners report that by incorporating visualization methods in meetings, it could be easier to present the results, which would increase memory retention of content and engagement among meeting participants. The practitioners further reported that visualization methods offer meeting participants the ability to synthesize the key points in the conversation and understand better how decisions were made in the meeting; therefore, engagement and focus of meeting participants increase (Pfister & Eppler, 2012). This is further supported by Brumberger (2007), who claims that practitioners who present visual representations create a level of flexibility in group discussion, whereby individuals are able to see the visualized information from alternative viewpoints. Brumberger (2007) notes that visualization representations will encourage productive thinking and group collaboration. Eppler & Burkhard (2004) also identify that sketching will encourage teams to share information and understand discussion points in a clear understandable language. As such, the data indicates that managers show an ambivalent attitude towards the use of visualization methods in management meetings. This could be attributed to the fact that managers do not understand fully the role of the visual practitioner and how it encourages an improved meeting experience.

5.6 The Emergence of the Visual Practice Model from the Conceptual Framework

Based on the literature review which was summarized in Chapter 2, a conceptual framework was developed by the researcher to guide this research. As the research progressed, a visual practice model emerged which highlighted key areas for both the business manager and the visual practitioner to consider in order to support and strengthen knowledge acquisition in management meetings. The researcher proposed a five-step process in the conceptual framework (see 2, *Review of the Literature*) to investigate how visualization methods can be structured for successful knowledge sharing, knowledge creation and knowledge documentation in management meetings. These steps include the role of manager/practitioner, visualization type, knowledge type, challenges and strengths, and knowledge acquired.

Figure 5.2 illustrates the final visual practice model which emerged from the findings identified here in chapter 5, *Discussion*. It also indicates how the model emerged from the experiential learning component of the conceptual framework by incorporating three levels of potential influencing factors which include: roles, challenges and benefits of real-time visualization methods. The visual practice model suggests a need to clarify roles within a management meeting, including how the visual practitioner can identify individual and group experiential learning which may impact and/or change tacit knowledge into explicit knowledge. The model also suggests how the visual practitioner can assist to identify the challenges of visualization methods and technology use for remote meetings. This approach will allow the manager to embrace the benefits of employee engagement, inter-organizational

development and knowledge sharing of real-time visualization use in management meetings that ultimately create new knowledge acquisition.



(Miller, 2017)

Figure 5.2. The emergence of the Visual Practice Model from the Conceptual Framework demonstrates improved knowledge acquisition in management meetings.

5.7 Limitations and Future Research

One of the strengths in this research is that the participants are both corporate managers and visual practitioners, thereby offering an important target population to evaluate accurately how each group interprets the effectiveness of visualization methods in a meeting setting. However, while providing some interesting viewpoints within this research on the effects of real-time visualization on knowledge acquisition in management meetings, this research study is not without its limitations.

A limitation resulting from the choice of two different participant groups is in regards to the format of questions within the online questionnaire survey which was originally developed to target the corporate manager. Following distribution of the online recruitment VideoScribe, many visual practitioners requested to join the research, thereby creating a challenge for the researcher to consider a categorization of these two groups for the data collection, analysis and results. Another limitation introduced in this research is that the researcher did not account for a very short participant recruitment and data collection timeline of less than eight weeks. As a result, only a small group of 33 participants were able to participate in the research, which is significantly less than the anticipated participant number of 150, which the researcher had originally planned to recruit for the survey and the focus group sessions.

Future research could employ a similar research design with a larger participant base of both the corporate manager and the visual practitioner to study the effects of real-time visualization on knowledge acquisition in management meetings. This approach can lead to further investigations by measuring the groups separate and collective viewpoints on the effects of visualization in management meetings. The additional research results could offer both groups a better understanding of how to collaborate to enhance the visualization meeting experience. Future research may also attempt to identify how e-moderation software programs, including digital sketch visualization programs are best suited for the purposes of supporting the remote meeting experience for both the manager and visual practitioner.

5.8 Final Summary

One of the strengths in this research is that the participants are both corporate managers and visual practitioners, thereby offering a target population that is important to evaluate the data from two separate viewpoints on the effectiveness of visualization in a management meeting setting. This research is considered to be applicable for the corporate sector and the visual practitioner community, as it provides anecdotal evidence that the use of visualization methods in meetings, compared to a traditional meeting setting, leads to statistically significant better knowledge management in organizations.

One implication of this study may be the suggestion to include collaborative decision-making between the corporate manager and the visual practitioner for meeting planning and training of new visualization methods. This approach would assist the participants to understand the advantages of visualization methods and also create a transparency of meeting expectations and desired outcomes for both groups.

As this research shows in the conceptual framework developed (see 2, Review of the Literature), by creating a plan for understanding, learning and facilitating visualization methods in meetings, this can lead to numerous positive effects on knowledge acquisition for individuals and team-work. In the future, this research could be complemented with qualitative studies such as manager and practitioner observation of visualization training sessions, and planning and facilitation of meeting discussion points using visualization methods. Most importantly, the researcher encourages organizations to consider the benefits of visualization methods and tools in management meetings, which allows employees the opportunity to improve their knowledge sharing, knowledge creation and knowledge documentation in team-work.

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Appendix A

Letter of invitation – Request for Consent

**Evaluating the Impact of Real-Time Visualization on
Knowledge Acquisition in Management Meetings**

LETTER OF INTRODUCTION – REQUEST FOR CONSENT

Date: _____, 2017

Dear _____:

You are being invited to participate in a research study on *Evaluating the Impact of Real-Time Visualization on Knowledge Acquisition in Management Meetings*. In particular, as the researcher for this study, I am interested in evaluating how business leaders could gain a better understanding of how real-time visualization tools and skills have an effect on knowledge acquisition of managers to improve business efficiencies and human resources management.

That is, as the researcher for this study, I am interested in studying how managers interact and learn with the use of real-time visualization tools and how sketch-based visualization and e-moderation software tools are used in management meetings. As the researcher, I will also explore how managers may see potential to improve business efficiencies and human resource management with the implementation of real-time visualization tools in management meetings.

This research will take a maximum of 6 months. During this time, I will offer participants the opportunity to participate in an online survey and/or participate in a 1-hour focus group meeting live in-person or via videoconference meeting using real-time visualization tools to collect data information.

At the start of the research, each participant will be asked to fill out a brief and confidential questionnaire. Following, each participant will complete an online survey questionnaire directly related to the research.

By participating in this research, you may also benefit other organizations to better understand the benefits and challenges of using real-time visualization in management meetings and thus potentially creating an avenue for further learning. You may find participation in the focus group sessions of the study enjoyable and informative as it will offer the opportunity to review and discuss your experiences and insight for using real-time visualization tools within management meetings with other industry business leaders.

There are no anticipated risks or discomforts related to this research. However, if you feel

uncomfortable with any part of this study at any time, you have the right to terminate participation without consequence.

Several steps will be taken to protect your anonymity and identity. Firstly, your name and personal information will be kept confidential. Names will be translated into ID codes and all data collected, will be labeled with the ID codes rather than your names. The tapes and transcripts of the focus group sessions, along with any other data collected, will be securely stored at UOIT under the lead researcher's supervision over a three-year period and will be destroyed after 5 years. By consenting to participate, the participant does not waive any legal rights or recourse.

At no time, will your name be used or any identifying information revealed. The only person, other than the researcher and yourself, who will view the raw data (audiotapes & completed surveys) will be the researcher's Masters Thesis supervisor, Dr. Janette Hughes, who is the co-researcher of this study.

Your participation in this research is completely voluntary. Although I cannot offer you any compensation, I can provide you with a summary of the research findings to share within your organization. If you choose to participate in this study and then change your mind, you may withdraw from the study at any time for any reason. If you do this, the work (data) will not be used, and that no more information or data will be collected from you from that point on.

The results from this study will be reported in general terms in the form of speech, writing, photograph or video that may be presented in manuscripts submitted for publication in scientific journals, or oral and/or poster presentations at scientific meetings, seminars, and/or conferences.

If you have any questions concerning the research study or experience any discomfort related to the study, please contact the researcher Leslie-Ann Miller at leslieann.miller@uoit.net

You may also contact the researcher's Masters Thesis Supervisor, Dr. Janette Hughes at Janette.Hughes@uoit.ca

I have read the above information regarding this research study on *Evaluating the Impact of Real-Time Visualization on Knowledge Acquisition in Management Meetings*, and consent to participate in this study.

Leslie-Ann Miller, M.A. Candidate, UOIT
leslieann.miller@uoit.net

(Printed Name)

(Signature)

**Evaluating the Impact of Real-Time Visualization on
Knowledge Acquisition in Management Meetings**

CONSENT FORM

Participant Concerns and Reporting:

If you have any questions concerning the research study or experience any discomfort related to the study, please contact the researcher Leslie-Ann Miller at leslieann.miller@uoit.net

You may also contact the researcher's Masters thesis supervisor, Dr. Janette Hughes at Janette.Hughes@uoit.ca

This study has been approved by the UOIT Research Ethics Board REB #14138 on _____, 2016.

Participant:

I have read the *Letter of Introduction/Request for Consent* relating to the above titled research, I understand the proposed research and my questions have been answered to my satisfaction.

I understand the following (please check each item you understand and agree to):

- I have the right to withdraw from the study at any time if I do not feel comfortable and I understand that the information collected is for research purposes only and no personal identifiers will be used.
- If I withdraw, I have the option to allow the data collected to remain in the study or be destroyed.
- Participation is entirely voluntary and that choosing to participate or choosing to withdraw from the study has no negative consequences for me or the organization that I represent.
- Data will be collected through field notes, sketchnotes, graphic recording and audio/video/photo recordings. All notes and interview transcripts will be shared with participants for verification before any findings are analyzed and disseminated. I can choose to withdraw my contributions or clarify items with no negative consequences.

By signing below, I give my consent for participation in the research study.

**Title of Research Study: Evaluating the Impact of Real-Time Visualization on
Knowledge Acquisition in Management Meetings**

- I give consent for my work to be used as data
- I give consent to be recorded (audio/video/photo)

I give consent to be audio-recorded only

I give consent to be video-recorded only

I give consent to be photographed only

Full Name (please print): _____

Signature: _____

Date: _____

Appendix B

MEDEC e-Pulse Newsletter Announcement

Former MEDEC member company rep seeking participants for Masters research study MEDEC

Leslie-Ann Miller is an M.A. candidate in the Faculty of Education at the University of Ontario Institute of Technology (UOIT) in Oshawa, Ontario, Canada. With the UOIT Research Ethics Board approval on January 2, 2017 (REB #14138), Leslie-Ann will commence her thesis study that will focus on [Evaluating the Impact of Real-Time Visualization on Knowledge Acquisition in Management Meetings](#).

For more info, click here (info below)

Leslie-Ann Miller is an M.A. candidate in the Faculty of Education at the University of Ontario Institute of Technology (UOIT) in Oshawa, Ontario, Canada. With the UOIT Research Ethics Board approval on January 2, 2017 (REB #14138), Leslie-Ann will commence her thesis study that will focus on Evaluating the Impact of Real-Time Visualization on Knowledge Acquisition in Management Meetings.

A primary focus and aim of this research will be to explore the potential and restrictions of real-time visualization that managers have previously encountered, including collaborative hand drawings and/or visualization software tools for knowledge creation, knowledge sharing, and knowledge documentation. Additionally, this research will examine how managers see potential to improve business efficiencies and human resource management with the implementation of real-time visualization tools in management meetings.

Your organization is invited to participate in this research and you are welcome to contact Leslie-Ann Miller directly for additional information regarding her thesis research study.

Leslie-Ann Miller
M.A. Candidate
University of Ontario Institute of Technology
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289.200.8465
VideoScribe You Tube link: <https://youtu.be/A5cjdkRxvrU>

Appendix C

Recruitment VideoScribe



[Recruitment VideoScribe - UOIT REB approval #14138](#)

(<https://youtu.be/A5cjdkRxvrU>)

Appendix D

Demographic online survey - All participants

1. Please complete the following questions.

1. Contact email: _____

2. Country of residence: _____

3. Country of Origin: _____

4. Gender: Male ____ Female ____

5. What decade were you born in?
1940/1950/1960/1970/1980/1990's

6. Education level:
Secondary/College/Undergraduate degree/Masters/Doctorate/Executive Certificate

7. Level in organization:
Manager/Director/Vice President/CEO President/Principal Owner

8. Type of organization: _____

9. Years of professional management experience:
Less than 5 years
6-10 years
11-15 years
15 years+

Appendix E

Online Survey A – All participants

To identify managers that have participated in management meetings using real-time visualization tools/methods.

Note: Real-time visualization in management meetings is identified as follow:

- The use of e-moderation software and/or the use of creating sketch based templates and information within real-time.

1. Please rate the following based on your experience with using and/or participating in a real-time visualization management meeting.

	Yes	No	Maybe
10. Have you participated in a meeting that incorporated sketch based templates visualization tools?			
11. Have you participated in a meeting that incorporated e-moderation software visualization tools?			
12. Have you facilitated a meeting with visualization tools?			
13. Would you participate in a one-hour focus group session with a group of managers to share your experiences and ideas surrounding the value and/limitations of visualization tools? If your answer to the above question is 'Yes' or 'Maybe', please provide email address contact address.			

Appendix E (cont'd)

Online Survey A – All participants (cont'd)

14. How often have you participated in a management meeting where visualization tools were used for sharing of information? **Daily/Weekly/Monthly/Quarterly/Never**

15. Could you describe how you would typically facilitate a 'traditional' management meeting?

16. How is your comfort level with facilitating a real-time visualization meeting versus a traditional meeting? **Low/Medium/High/Not Sure**

Appendix E (cont'd)

Online Survey A – All participants (cont'd)

Real-Time Visualization Meetings versus Traditional Meetings

Instruction

17. Please select the value, based on your experience in management meetings, using real-time visualization versus regular traditional format meetings.

	Poor 1	Less Effective 2	No Difference 3	More Effective 4	Excellent 5	N/A 6
Meeting Flow						
Engagement of meeting participants						
Clarity of Objectives						
Clarity of Results						
Action Plan						
Interactivity of Participants						
Group Breakout Discussions						
Group Report-Out						
Knowledge Acquisition						
Knowledge Sharing						
Ease of Use in Follow-up Meetings						

Appendix E (cont'd)

Online Survey A – All participants (cont'd)

Real-Time Visualization Meetings versus Traditional Meeting Experience

18. How do you think a real-time visualization meeting differs from a traditional meeting?

Please explain.

19. Following your active participation in a real-time visualization meeting(s), how do you think your organization could benefit from incorporating visualization tools in management meetings?

20. Have you found any limitations from incorporating visualization tools in meetings?

21. Please rate the following based on your experience with real-time visualization meetings versus traditional meetings.

	Low	Medium	High
Overall managers' satisfaction with meeting.			
Interest in working with real-time visualization tools.			
Usability of documentation created with visualization tools.			
Interest in applying visualization methods to other meetings/training sessions.			
Interest in learning & using visualization skills/tools			
Value/ROI (return on investment) received versus anticipated value of using visualization tools in management meetings			

Appendix F

Focus group open-ended questions

1. Could you describe how you would typically facilitate a ‘traditional’ management meeting?
2. How often have you participated in a management meeting where visualization tools were used for sharing of information?
3. Which visualization tools have you discovered to be more effective for information flow? Which tools have you found to be more limiting and/or challenging for information flow?
4. Following your active participation in a real-time visualization meeting(s), how do you think your organizations’ could benefit from incorporating visualization tools in meetings?
5. How do you think a real-time visualization meeting differs from a ‘traditional’ meeting?
6. Please share with the group any limitations or challenges of use with facilitating real-time visualization meetings? How did you overcome the barriers?
7. Please describe how you have implemented or change the manner of meeting facilitation in your organization after participating in a real-time visualization meeting? Are your meetings run more efficiently? Please explain.
8. How is your comfort level with facilitating a real-time visualization meeting versus a ‘traditional’ meeting? Please explain.

Appendix G

Focus Group Notes (sample question and answers)

1. Could you describe how you would typically facilitate a ‘traditional’ management meeting?

Participant 1:

- “Two ways – It depends on the nature of my work - if it’s a team meeting, then we usually have fix agenda items, topic agenda items, chair and minutes of meeting.”
- “If it’s a specific meeting (i.e. finance or programming) – then we will use a television in the meeting and go through all documents.”
- “If it’s a facilitated meeting – then we will use flip charts and HQ – there will be a recording of the meeting.”
- “If the point of meeting is brainstorming – then building content is priority.”

Participant 2:

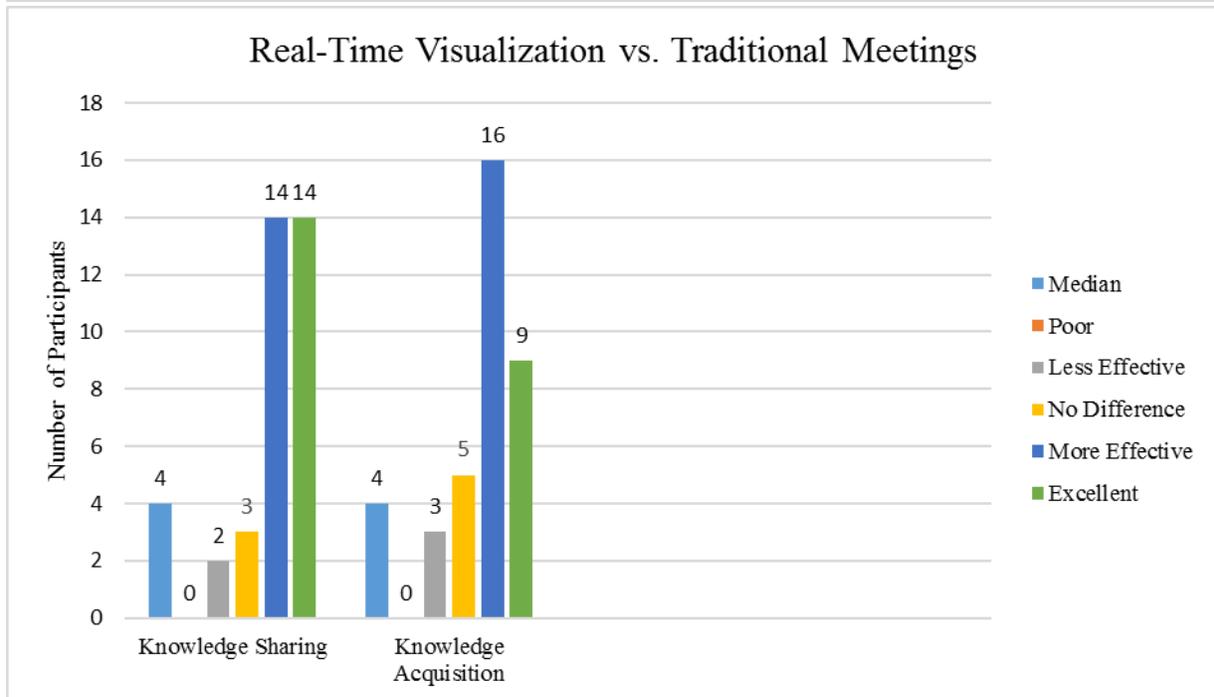
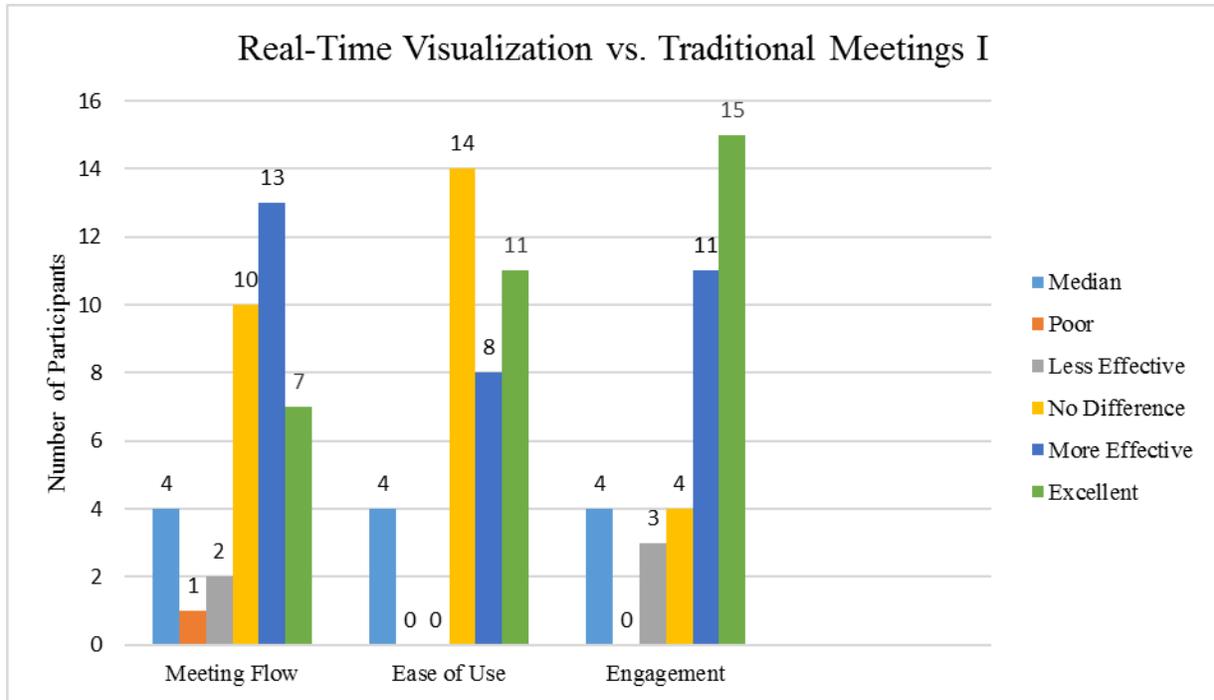
- “We use an agenda - go through entire agenda - If it’s a PowerPoint set up before.
- “If project planning (i.e. 30 pages) – we work through it thematically and focus on the most important issues at hand.”
- “If it’s a task group meeting, then slotting the science into a particular schedule and around the strategies.”

Participant 3:

- “# of invitees at table, sitting, received an electronic agenda, also hard copies are typically on hand – though most meeting participants don’t read prior to meeting.”
- “Introductions are 1st, reading of the previous meeting minutes, minutes approval, agenda review, there is a recorder of the minutes, group reviews action items, keeping people on topic is focus.”

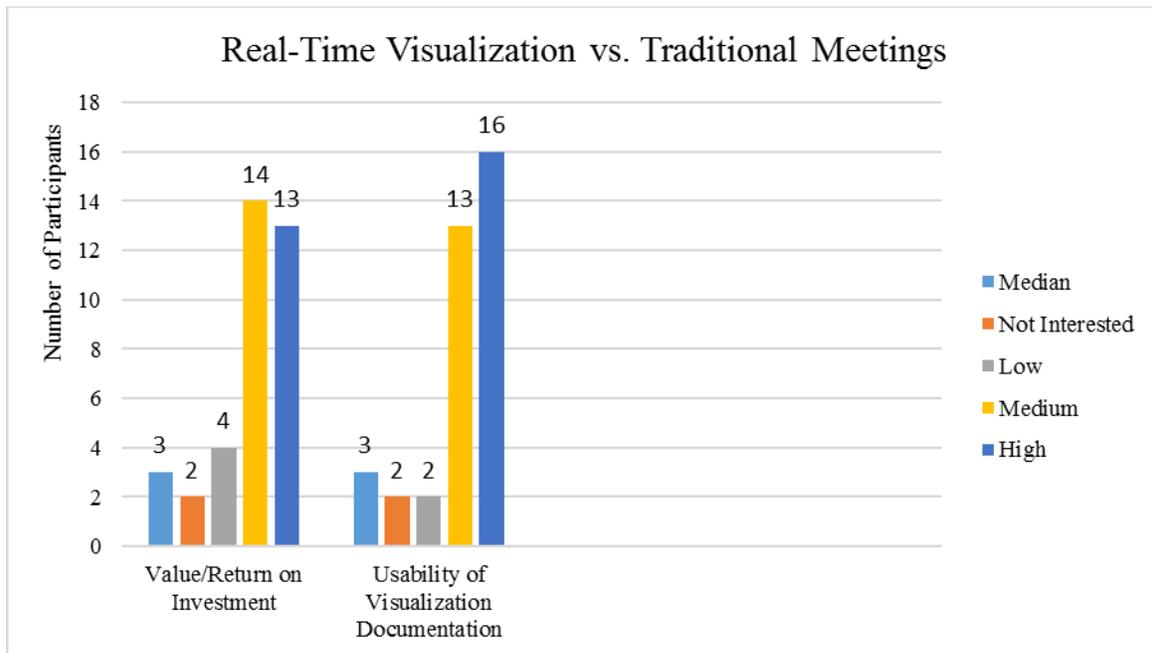
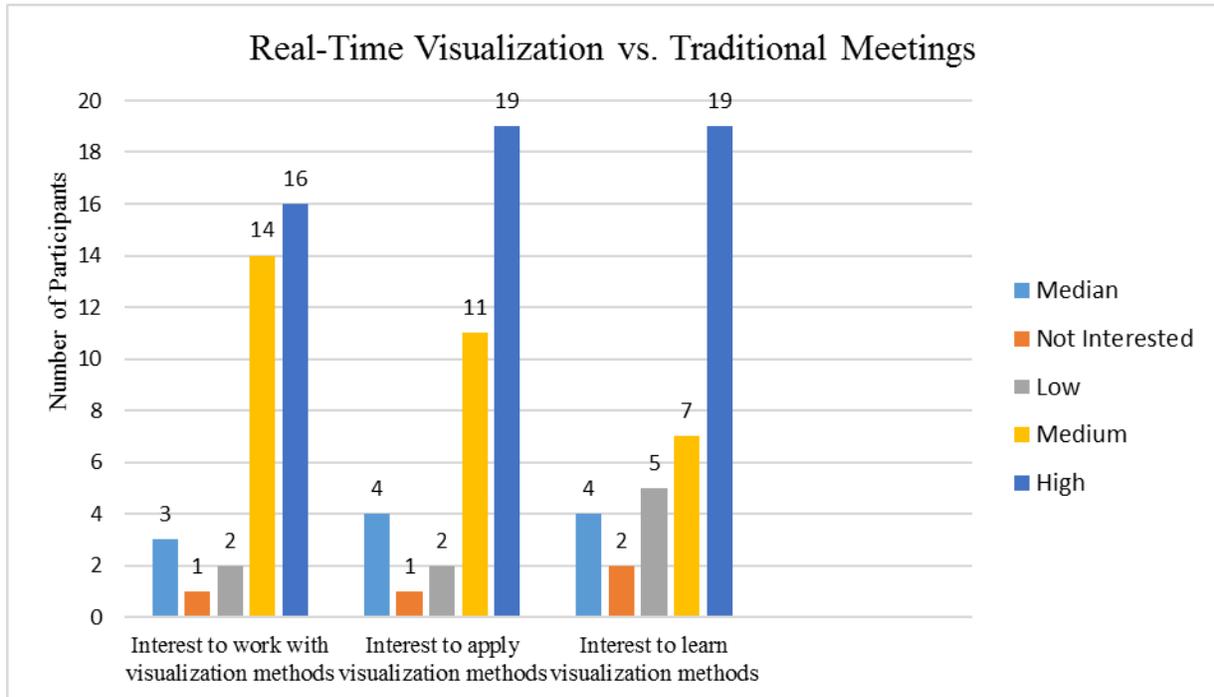
Appendix H

Clustered Bar Chart I



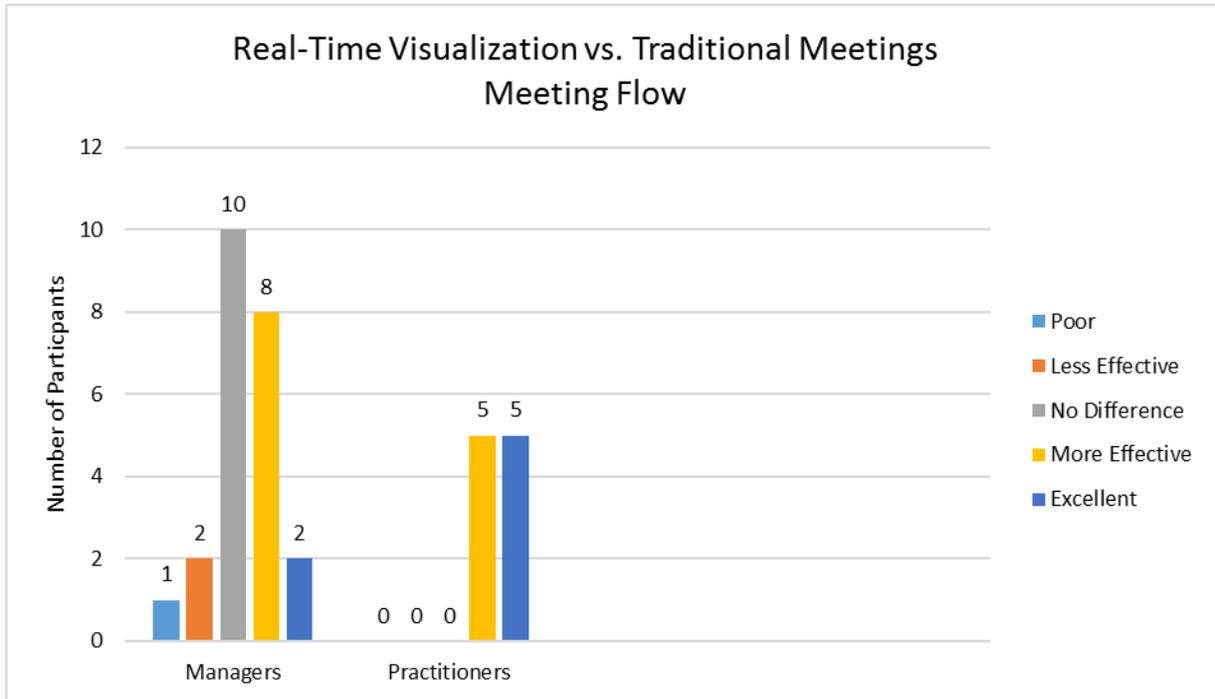
Appendix I

Clustered Bar Chart II



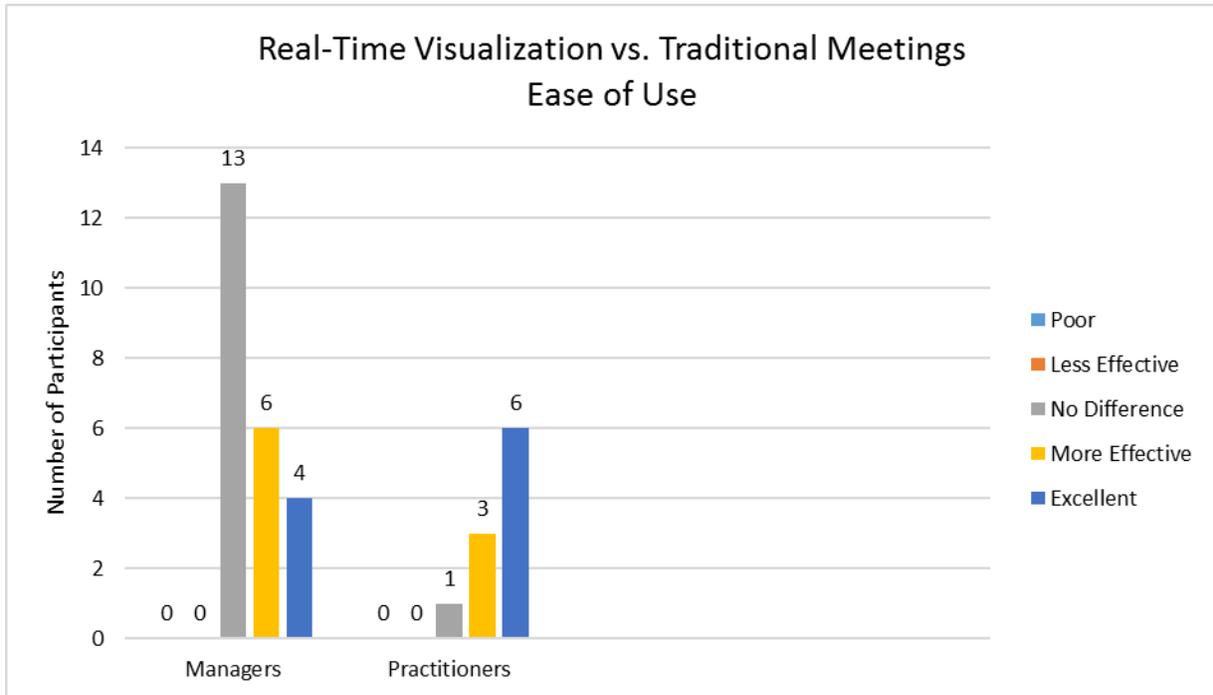
Appendix J

Clustered Bar Chart III



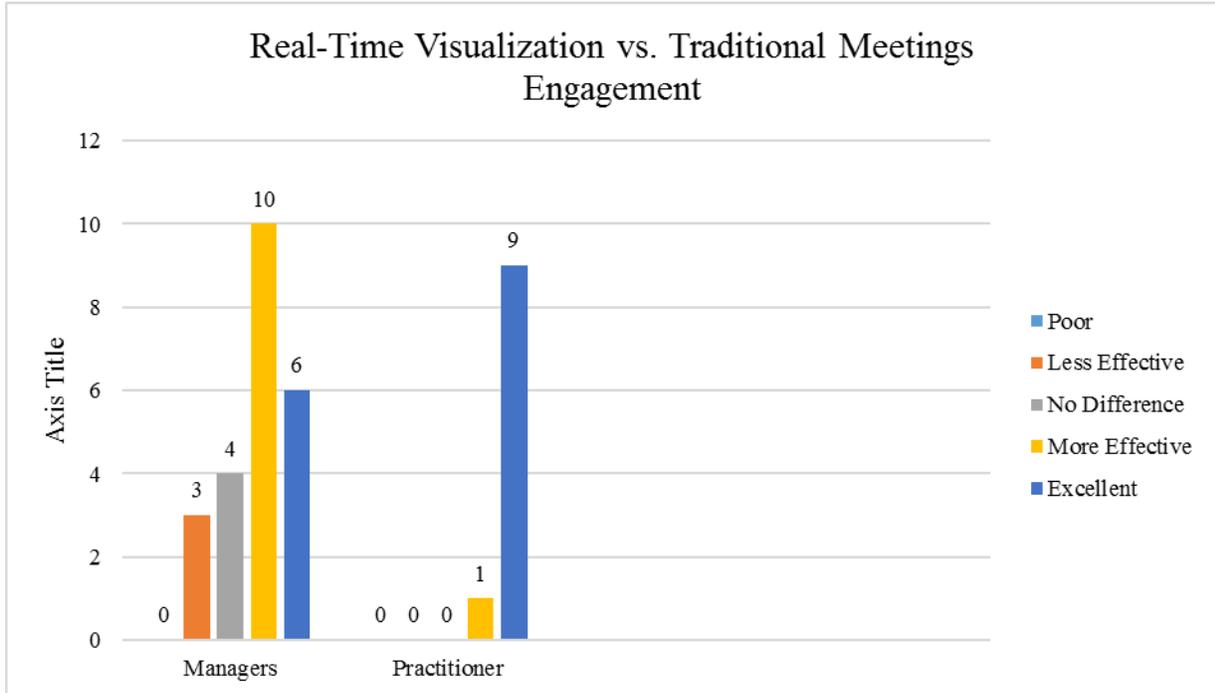
Appendix K

Clustered Bar Chart IV



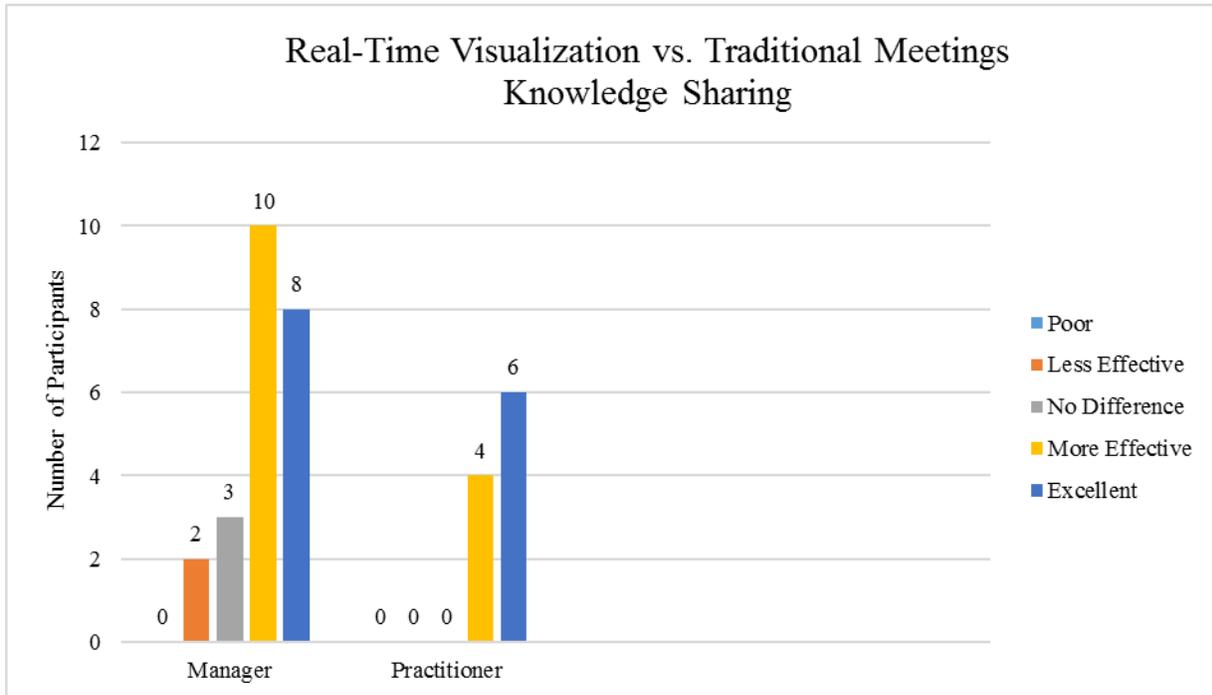
Appendix L

Clustered Bar Chart V



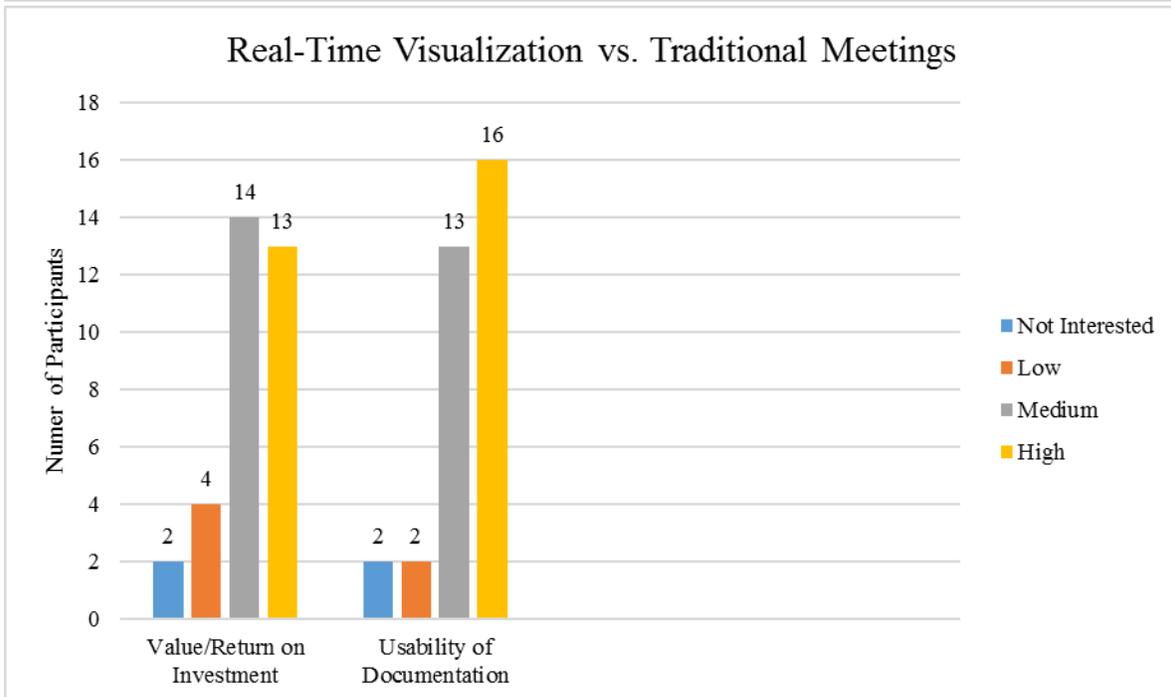
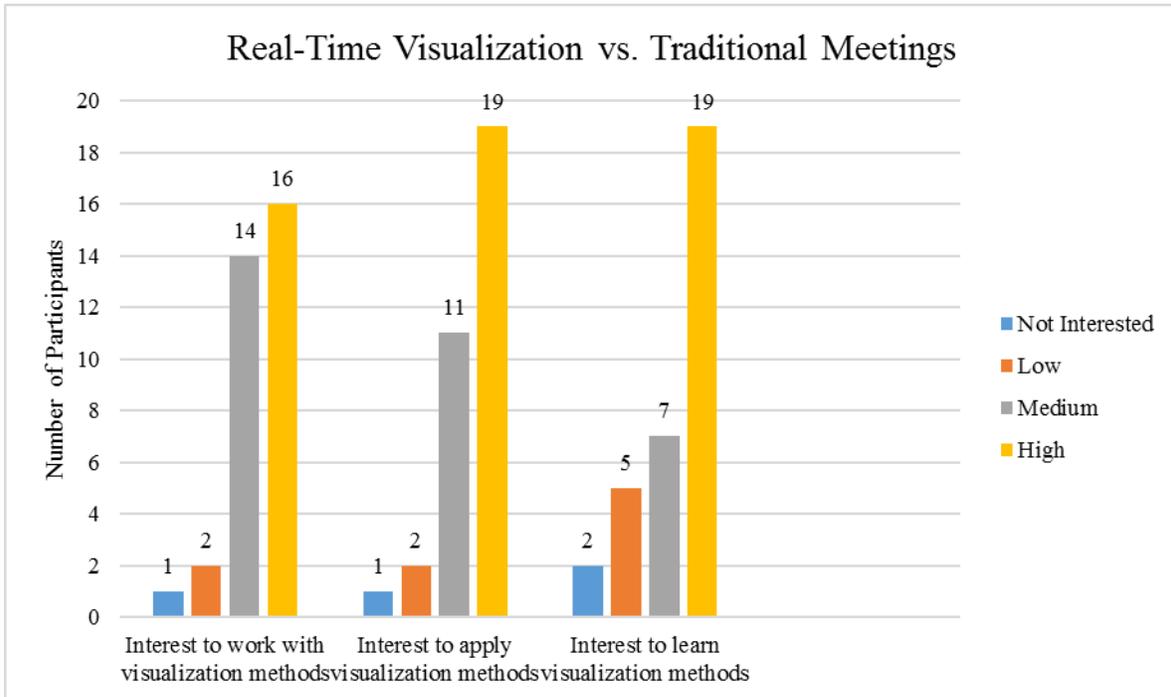
Appendix M

Clustered Bar Chart VI



Appendix N

Clustered Bar Chart VII



Appendix O

Real-Time Visualization Frequency Analysis I

Item	Median	Mode	IQR
Meeting Flow	4	4	1
Ease of Use	4	3	2
Engagement	4	5	1
Knowledge Sharing	4	4.5	1
Knowledge Acquisition	4	4	1.5

Five point Likert Scale (1- Poor to 5 - Excellent)

¹Poor

² Less Effective

³No Difference

⁴ More Effective

⁵ Excellent

Appendix P

Real-Time Visualization Frequency Analysis II

Item	Median	Mode	IQR
Interest to work with visualization methods	3	4	1
Interest to apply visualization methods	4	4	1
Interest to learn visualization methods	4	4	1
ROI/Value	3	3	1
Usability of Documentation	3	4	1

Four point Likert Scale (1 – Not Interested to 4 – High)

¹Not Interested

²Low

³Medium

⁴High

Appendix Q

Research Ethics Board Approval Notice

researchethics@uoit.ca <researchethics@uoit.ca> 9 January 2017 at 13:55
To: "Dr. Janette Hughes (Primary Investigator)" <janette.hughes@uoit.ca>
Cc: "Ms. Leslie-Ann Miller (Student Lead/Post-Doctoral Lead)" <ripplethink@gmail.com>, researchethics@uoit.ca

Date: January 09, 2017
To: Janette Hughes
From: Shirley Van Nuland, REB Chair
Title: Evaluating the Impact of Real-Time Visualization on Knowledge Acquisition in Management Meetings
Decision: APPROVED (effective January 2nd, 2017)
Current Expiry: January 01, 2018

Notwithstanding this approval, you are required to obtain/submit, to UOIT's Research Ethics Board, any relevant approvals/permissions required, prior to commencement of this project.

The University of Ontario, Institute of Technology Research Ethics Board (REB) has reviewed and approved the research proposal cited above. This application has been reviewed to ensure compliance with the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS2 (2014)) and the UOIT Research Ethics Policy and Procedures. You are required to adhere to the protocol as last reviewed and approved by the REB.

Continuing Review Requirements (all forms are accessible from the [IRIS research portal](#)):

- **Renewal Request Form:** All approved projects are subject to an annual renewal process. Projects must be renewed or closed by the expiry date indicated above ("Current Expiry"). Projects not renewed within 30 days of the expiry date will be automatically suspended by the REB; projects not renewed within 60 days of the expiry date will be automatically closed by the REB. Once your file has been formally closed, a new submission will be required to open a new file.
- **Change Request Form:** Any changes or modifications (e.g. adding a Co-PI or a change in methodology) must be approved by the REB through the completion of a change request form before implemented.
- **Adverse or Unexpected Events Form:** Events must be reported to the REB within 72 hours after the event occurred with an indication of how these events affect (in the view of the Principal Investigator) the safety of the participants and the continuation of the protocol (i.e. un-anticipated or un-mitigated physical, social or psychological harm to a participant).
- **Research Project Completion Form:** This form must be completed when the research study is concluded.

Always quote your REB file number (**14138**) on future correspondence. We wish you success with your study.

Dr. Shirley Van Nuland
REB Chair
shirley.vannuland@uoit.ca

Janice Moseley
Research Ethics Coordinator
researchethics@uoit.ca

NOTE: If you are a student researcher, your supervisor has been copied on this message.

Appendix R

Tri-Council Policy Statement on Ethics (TCPS2: Core)

