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Adoption of Innovation: Exploring the Design and Implementation of a Cardiovascular Registry Project

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Adoption of Innovation: Exploring the Design and Implementation
of a Cardiovascular Registry Project

by

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A THESIS

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Abstract

Advanced data technologies are permeating the healthcare environment, yet little is known about the role of learning in these change events. Literature on advances of data science for use in healthcare predominantly focuses on the computational and analytic methods, barriers and benefits, as well as the potential impact on the industry and professional roles. Few studies have explored health professionals' experiences and perspectives on the integration of data science technologies in practice.

In this qualitative, descriptive case study, I explored the experiences of 16 health professionals who had a role in a change event related to a cardiac registry project in western Canada. Study participants included project team members, clinicians, research collaborators, and academic and clinical institution staff and leaders. Semi-structured interviews were used to explore the experiences of participants to better understand the conditions that shaped the change event, the learning strategies employed, and the factors that contributed to the successful adoption of innovation.

Findings from the study revealed that people play a central role in the success of a change event and project implementation. While three additional themes emerged from the data, namely the environment, learning, and innovation, it was the individuals, teams, and relationships that function within those elements that were critical to the success of the registry project. The results of this work provided insight into the necessary conditions to support successful adoption of advanced data technologies and guided recommendations for future change events.

Preface

This thesis is original, unpublished, independent work by the author, Melanie King. The qualitative study reported in Chapters 3-5 was approved by the University of Calgary Conjoint Faculties Research Ethics Board under Ethics Certificate ID REB-20-1183.

This thesis has been professionally edited for format requirements only.

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List of Key Terms

Advanced data technologies: A broad term selected for this proposal to incorporate a wide variety of data-related tools and technologies; variations in terms used across the literature may be specific to a kind of data-driven technology (reflecting a particular tool or technique) whereas other terms are used to capture broader generalizations, including health information technologies or data-driven technologies.

Artificial intelligence: Intelligent behaviour of a computer in performing human-level cognition-related tasks (Malik et al., 2019); a broad term used to describe a variety of computer-driven tasks, such as machine learning or natural language processing.

Big data: Extremely large data sets that cannot be analyzed or interpreted using traditional data processing methods; requires use of sophisticated analytic tools (Krittanawong, 2018).

Data science: All aspects related to the use of existing information contained in data, including methods, processes, and systems to extract knowledge from the data, often through novel techniques such as artificial intelligence (Dilsizian et al., 2014).

Health professionals: This term is used broadly in the proposal, intending to capture the multidisciplinary audiences involved in the implementation of advanced data technologies, including clinicians (such as physicians, nurses, and other allied health professionals), research professionals (such as investigators, coordinators, and analysts), and departmental or institutional leadership.

Health informatics: The use of information and information technology systems within the healthcare environment (Bath, 2008).

Learner(s): The target audience for which an educational program is designed. This is used to distinguish from students as this often denotes primary, secondary, or post-secondary audiences as well as distinguishing health professionals in general from those that are the target audience for a given program.

Machine learning: An artificial intelligence technique (Lai & Mamzer, 2020) that allows computers to perform the work of complex tasks based on algorithms using the relationships between variables to predict outcomes (Sidey-Gibbons & Sidey-Gibbons, 2019).

Precision medicine: A tailored medical treatment based on the individual characteristics of a patient made possible by big data and the use of artificial intelligence and machine learning (Ahuja, 2019).

Professional development: A wide variety of specialized training, formal education, and/or advanced professional learning intended for a variety of individuals and implemented by various industries to improve upon professional knowledge, competence, skill, and personal effectiveness (Hilty, Liu, Stubbe, et al., 2019)

Chapter One: Introduction

In the following chapter, I provide an overview of the selected topic and my research study. Starting with a background section, I introduce the topic that frames my work. Next, I describe important aspects that led to the selection of the topic and research questions, including a statement of the problem as well as context and rationale for the study. I then present my research questions and outline the methodology and methods used. Finally, I discuss the significance of the study, situate my role as the researcher, and provide an outline for the organization of the dissertation.

Background

The purpose of new technology is often to improve the work done in organizations (Black et al., 2004), such as the technological advancements that continue to drive innovation and change in the healthcare environment (Dorado-Diaz et al., 2019). Over the past few decades, a multitude of information and data technologies including the adoption of electronic records, biomedical and engineering tools, robotics technology, and artificial intelligence have transformed the healthcare sector (Pepito & Locsin, 2019). Increasing amounts of health-related data and advanced analytical techniques are driving a paradigm shift in healthcare (Jiang et al., 2017). Despite these technological advances, integration of these new tools into practice is slow (Liyanage et al., 2019), perhaps because the healthcare sector is unable to integrate tools at the same pace as the technology develops (Lai & Mamzer, 2020).

The health system is an environment layered with complexity, including a variety of individual, group, and organizational-level considerations (Chandler et al., 2016). This complex environment is also layered with ongoing changes; as a result, health professionals are continually asked to adapt to new devices, procedures, tools, and technologies (Lluch, 2011).

The purpose of my study was to explore how healthcare professionals and collaborators experienced and contributed to an adoption of innovation change event. This allowed for consideration of the conditions required for successful adoption of new behaviours and implementation practices during this change event. My project was initially designed to focus on the experiences of health professionals during a data-related change event but pivoted to focus on the innovation project team as well as institutional staff and leadership collaborators to unpack the conditions, processes, and change practices that contributed to the experience. Through this exploration of experience, aligned with considerations of the context and environment in which these events occur, valuable insights may contribute to successful change events in the future.

Statement of the Problem

Developments in data science, including artificial intelligence (AI), have been ongoing for decades as the increasing availability of big data provides opportunities for significant advancement in a variety of industries, including healthcare (Dwivedi et al., 2019). There are increasing efforts to integrate data technologies into the healthcare environment, however there is a lack of evidence to inform the best practices in which to work with healthcare professionals as learners and agents in these change events. Historical change events, such as the integration of electronic medical records into practice in the 1990s and early 2000s, have been implemented with a variety of problematic and controversial results (Bar-Lev, 2015). Implementation issues are often attributed to the disruption of roles and tasks that are complicated by power differences, organizational politics, communication breakdown among stakeholders, fear of technology, and poor change implementation processes (Black et al., 2004; Robey & Boudreau, 1999; Xu et al., 2019). Many organizations are unable to optimize the implementation process, and therefore unable to realize the benefits of the new technology (Robey & Boudreau, 1999).

As the healthcare industry moves into a more advanced phase of technological implementation of a variety of data tools and technologies, interconnecting topics of change management, learning, and implementation practices will be critical to supporting successful change events. The literature offers little insight to manage the disruption associated with advanced data technologies, particularly from an educational lens. Educational research in the health sector primarily focuses on post-secondary education, such as undergraduate medical or nursing education. Literature on adult learning, professional development, and behaviour change theory have contributed to the current knowledge base on professional learning for current healthcare practitioners. The context for this learning is often in relation to traditional professional development practices, such as learning new protocols or attending workshops (Fullan, 2007). The integration of data-related tools into the professional development space are still rather novel. This study was designed to better understand the phenomenon of data-related change events, the results of which provide some insight into further research and recommendations for the case study population for future change events.

Context of the Study

In my study, I explored how healthcare professionals in western Canada have experienced and contributed to the planning, development, and implementation of a change event related to a complex cardiac registry project. Healthcare professionals are highly educated and commonly work in unpredictable and changing environments. While changes in tools, policies, guidelines, and technologies are common, these change events are complex due to the nature of healthcare systems and institutions (Robert, 2019). Many areas of practice operate 24 hours a day in complex settings. Healthcare professionals must manage ongoing care responsibilities with opportunities to learn, develop, and implement changes in professional practice (Hilty et al.,

2019). Healthcare systems in Canada are organized provincially, yet even within a province the range of tools, technologies, and practices may vary based on policies or decisions made within departments, institutions, or regions. This complicated landscape poses challenges for the integration of advanced technologies into research and clinical care on a broad scale (Fan et al., 2018).

While change is not uncommon in the healthcare sector, change management practices specific to the integration of advanced technologies are still evolving alongside the technologies themselves. The literature is overwhelmed with opinion pieces and editorials on the potential for advanced technologies in healthcare, but little is known about how to apply change management practices to this integration and how to best support healthcare professionals to learn, adapt to, and adopt these new tools.

The technological landscape for health information is changing. Provincial and regional systems continue to roll out new software and technologies in care environments in an attempt to integrate existing and future real-time electronic health records systems and provide a central access point for administrative health data, such as the records created in any interaction with the health system (Alberta Health Services, 2020). With the advent of these types of electronic systems, new possibilities will arise for the collection, storage, use, analysis, and reporting of large amounts of patient data that can be used to develop predictive and autonomous programs using AI techniques such as machine learning. Designing and implementing these complex projects and considerations for supporting health professionals to adapt to these new technologies is essential.

Rationale for the Study

In 1970, Schwartz proposed that the computer would become an intellectual tool that would fundamentally reshape the healthcare system. Fifty years later, AI continues to move forward in industries and organizations around the world, promising benefits such as efficiencies and cost savings (Becker, 2019). The rationale for this study stems from the continuing trend to integrate AI innovations into healthcare (Malik et al., 2019), yet little is known about how to support professionals in adapting to this change. While advancements in technology have moved at a rapid pace in other industries, the integration of these tools is lagging in many healthcare settings (Liyanage et al., 2019). The healthcare industry has an opportunity to embrace these tools to improve care, and perhaps a responsibility to do so as well, as AI is well-positioned to lower costs, increase productivity, predict risk, and prevent complications (Ahuja, 2019; Darcy et al., 2016).

The field of cardiovascular care and research has been at the forefront of early integration of data advancements into practice (Dorado-Diaz et al., 2019) and remains influential in the integration of AI into medicine (Becker, 2019). Examples include devices such as internal cardioverter-defibrillators, which use algorithms to detect ventricular fibrillation and deliver a shock to the heart (Darcy et al., 2016). Other common areas that employ advanced data technologies include research and care for heart failure (Shameer et al., 2017), cardiac imaging (Samad et al., 2018), and ischemic heart disease (Wang et al., 2017). The selection of cardiovascular health as a case study will provide an opportunity to study an area of healthcare that has, as a discipline, been among the early adopters of advanced technologies made possible with big data. By engaging the cardiovascular field for the case study, I was able to explore the

experiences of those who have already participated in this type of data-related change event to uncover insights about the experience.

The purpose of my study was to contribute to the literature about the use of data science with a unique, and underreported, focus on effective learning strategies and change practices required to successfully integrate advanced data technologies in the healthcare environment. Through an exploration of how team members and collaborators have contributed to and experienced such events, it may be possible to provide recommendations to manage similar change events as advanced data technologies continue to become part of research and practice environments.

Research Questions

In my study, I explored the adoption of innovation in an environment that includes both a tertiary care site and an educational institution. The population of interest included the project team and the local staff and leadership collaborators who played a role in the design and implementation of the innovation. The following questions guided this study:

- What are the conditions required to support successful adoption of data-related innovations in the health professions?
- What is the role of learning in supporting the adoption of data-related innovations?
- What were the experiences of team members and collaborators who played a role in the adoption of innovation change event?

Overview of Methodology and Methods

My study was designed using a qualitative case study approach that was guided by a social constructivist philosophical foundation. The philosophical assumptions were grounded in a relativist perspective that considers multiple realities, or multiple meanings, of events as

individuals or collections of individuals experience them (Denzin & Lincoln, 2001). Social constructivism is further understood and applied to the context of the healthcare environment by considering the ways individuals think, learn, and develop new knowledge as interwoven with the environment in which they work and dependent upon the activities and processes of that community (Bang, 2015). This approach allowed for the consideration of subjective interpretations based on the views and experiences of participants and recognizes that there is no one truth to uncover.

The qualitative case study design involved document analysis and semi-structured interviews, a recognized approach when seeking to gain an understanding of phenomena that are located within complex social units (Merriam, 2009). Merriam's approach to case study involves a defined unit of analysis within a bounded context; the case for this study is healthcare or research professionals involved in a cardiac registry project in western Canada. Participants included individuals employed by a healthcare or academic institution who contributed to the design and/or implementation of advanced data innovations related to the cardiac registry project. Participants were engaged in semi-structured interviews following a standard set of questions and exploring pertinent experiences and topics as they arose. As detailed in Chapter Three, Merriam's approach to case study and Saldana's process of analysis guided the data collection and thematic analysis for this work.

Significance of the Study

The integration of advanced data-related technologies is still somewhat novel in many areas of healthcare and research. With advancements in the design and use of electronic records and increasing amounts of digitized patient data over the past two decades, it is now possible to maintain databases with extremely large data sets that can be used to inform precision medicine

through AI techniques such as machine learning (Krittanawong, 2018). Precision medicine has been called a cultural transformation in medicine and health, one that is only made possible through advanced technologies and developments in AI techniques (Mesko, 2017).

My study was designed to address a gap in the literature at a specific intersection of healthcare, advanced technology, innovation, and data science. First, I explored the common topic of data science in healthcare from a non-traditional lens of learning sciences. The frame of learning was overlaid with the principles of behaviour and change theory in an attempt to understand how learning can influence behaviour in the context of adaptation to advanced data technologies. Much of the literature reviewed focused on the analytical and computational aspects of these technologies and how they will perform in care environments. In my study, I examined the social and environmental contexts of the healthcare environment to better understand the influence of these significant factors on adoption of these advanced technologies in practice.

Second, my study contributed to the sparse qualitative research as the literature related to the adoption of technological innovations in healthcare is largely empirical or commentary. An exploration of the experiences of project teams, leaders, and collaborators with a change event in data science technologies is a unique approach. Some scholars have recommended the collaboration of healthcare professionals in the development of AI modelling and development (Mesko, 2017). However, the role of health professionals in informing the learning strategies associated with these change events, to our knowledge, has yet to be explored.

AI integration into healthcare and research is poised to significantly shape the evolution of the discipline in the coming years (Scott et al., 2019). Despite the role of automated machines, or robots, in areas such as robotic surgery, AI is better situated to assume a role as partner, not a

replacement, in medicine (Ahuja, 2019; Krittanawong, 2017). The use of AI to meaningfully process data that the human brain cannot comprehend will equip health professionals with the knowledge to make better decisions (Rajkomar et al., 2019).

As healthcare environments continue to integrate these new technologies, practitioners are at the forefront of adopting, and adapting to, the practice and behaviour changes associated with these new tools. From my review of the literature, no studies were found that considered the learning sciences perspective of the adaptation to changes in practice, particularly in the context of recent advancements in data-related tools. While my study is specific to a particular case and context, the findings provide insight into how these changes events are designed and implemented and highlights beneficial learning strategies and conditions that promote adoption and behaviour change.

Positionality of the Researcher

Context and change theory have been among my primary interests since I began working in clinical practice as a registered nurse. These interests have contributed significantly throughout the phases of my career, which can be summarized as a clinical phase, a research/project phase, and a transition into the educational focus that drew me to this doctoral program and dissertation topic. During my clinical nursing phase, I worked in a variety of places where context was crucial, including low-and-middle-income countries in Africa as well as several years in northern Canada. Throughout these experiences, I found the context and environment of these communities to have a significant impact on nearly every aspect of life and healthcare in these regions, including the professional lens of resources and learning, as well as the profound effects of policy, politics, environment, culture, language, and more on the lives and health of patients. In the second phase of my career as a program manager at an academic

institution, I began to build my own skills not only as a program manager, but as an educator. My role was to manage programs that build capacity to change the way people conduct health research. The role of education, of learning, in this goal to create a significant change in practice also inspired my thinking about the way this learning takes place and the significant change events practitioners experience throughout their careers.

These roles and experiences have shaped the way that I think and how I perceive the world. I wholeheartedly believe in multiple realities, that two individuals can share a collective experience but interpret it in ways that are entirely unique. As a practitioner, I have witnessed how histories, lifestyles, experiences, traumas, and cultures have shaped the ways individuals and communities experience health issues. I believe multiple forms of data are needed to understand both a broader and deeper picture, yet my priority lies in exploring the human experience.

My personal role as a hybrid professional along the boundaries of health, research, and education has provided me with the ability to understand these various roles and disciplines that also make up the membership of the selected case study population. My background and varied experiences offered different perspectives from which to view and interpret the data as well as the ability to dig deeply into the topics of this project with an insider's perspective of the professional worlds of the study participants. While my own values and biases continue to permeate my work, my experience as a practitioner has trained me to keep my own feelings aside when possible. My experience in research has taught me to acknowledge those values and see them as part of my own research process.

Organization of the Dissertation

In the introductory chapter of this dissertation, I have outlined the topic, including the context, rationale, and significance of the study. In Chapter Two, I provide a review of relevant literature which frames the topics presented as well as the theoretical and conceptual frameworks that guided this study. Chapter Three includes the research design, methodology, methods, and ethical considerations that governed the conduct of the study. In Chapter Four, I provide an overview of the study participants and present the analysis of the participant interviews and document review. Chapter Five includes a discussion of the findings, presenting the thematic analysis from Chapter Four in relation to the literature and addressing key considerations and responses to the research questions. In Chapter Six, I present the contributions of the study, including implications for practice and future research, and provide concluding remarks.

Summary

In this introductory chapter, I have provided a general overview of the study, including the significance, context, and rationale for the selected topic as well as the research questions posed and the methodology and methods used to address them. In the next chapter, I review and synthesize the literature that informed this study.

Chapter Two: Literature Review

The literature review provides a broad summary of the main topics that together informed my research study. I provide an overview of the relevant learning theories, particularly adult learning, andragogy, and professional development in the health professions. Next, the key topics in data science are presented, highlighting the significance, issues, and current state of data technologies in healthcare. A brief examination of select representative studies that have components of data integration in the healthcare environment demonstrates the outcomes, successes, and challenges of this unique area of research. Additional literature that aligns with key emergent topics is also presented, including innovation in healthcare and implementation science. Finally, I explain the theoretical framework and philosophical underpinnings that guided this work, providing a lens through which to view the topics and concepts that are discussed. This is followed by the conceptual framework that helped to inform this work as part of the initial study development.

Adult Learning

Adult learning is distinct from primary and secondary education in that it seeks to provide content that is specific to the needs and requirements of adults, which can be different from the learning needs of children (Knowles, 1978). Knowles (1984) described key assumptions about adult learners, including the need for self-efficacy, the need for problem-centered learning, understanding why the learning is important, viewing the learning as important to their role, being ready to learn, and being motivated to learn (Knowles et al., 2014). From the early works on adult learning, it has been described as seeking to address situations related to work, family, or community that require adjustment or a new way of accomplishing a task (Lindeman, 1926). The need for, and importance of, education on the job was recognized by Lindeman (1926) who

identified the ongoing process of continuing education in adulthood and professional life. While these assumptions and concepts have been challenged as more relevant for best practices of adult learning, rather than learning theories themselves (Kawalilak & Groen, 2020), these insights are still central to current rhetoric on adult learning today and have impacted much of the discourse of the discipline.

Adult education is influenced by a host of societal, cultural, and technological changes that have occurred since the early days of adult learning theory (Merriam & Bierema, 2014). Kawalilak and Groen (2020) described adult learning as impacted by a variety of factors, including social and cultural factors, and is experienced in multiple ways, including formal, nonformal, incidental, and tacit learning. Our understanding of adults as learners is also informed by a range of disciplines, such as psychology and sociology, and founded in orientations of behaviourism, humanism, cognitivism, social cognitivism, and constructivism (Kawalilak & Groen, 2020; Merriam et al., 2007). Adult learning can be further explored through the concept of andragogy.

Andragogy

The term andragogy was coined to differentiate adult learning theory, methods, and philosophy from pedagogy, which focuses on youth learning (Knowles, 1978). More specifically, the theory of andragogy addressed the idea that adults have learning needs that are different from those of children, including aspects of cognition, life experience, and motivation for learning that are specific to adult life stages and roles (Merriam & Bierema, 2014). The critical assumptions and guiding principles of andragogy described adults as self-directed individuals, with experiences that provide a basis for learning, who are problem-centered and

desire practical application, have learning needs that align with changes in roles and society, and are intrinsically motivated (Knowles, 1996; Merriam 2001).

The theory of andragogy, commonly described as addressing the science and practice of adult learning, is not without tension. Discourse since the 1990s has questioned the assumption of adult learners' abilities to demonstrate the above characteristics as well as recognizing the societal constraints by which some individuals may not have the agency to engage in learning according to these assumptions (Merriam, 2001; Pratt, 1993). The role of sociocultural environment and previous experiences, then, includes not only the interpretation and application of new knowledge, but in contributing to the characteristics and practices of the individual learner.

Andragogy has changed in its presentation over the years due to this critical discourse. Andragogy was initially proposed as a theory of learning by Knowles (1978), however in response to criticism he reclassified the work as guiding principles that offer assumptions about the characteristics of adult learners (Merriam & Bierema, 2014). These assumptions about learner characteristics are intended to guide the planning, implementation, and evaluation of adult learning (Merriam, 2001). Ambiguous research findings have exacerbated the tension of the position of andragogy within educational theories and frameworks (Rachal, 2002). The risk of potentially overgeneralizing the characteristics of adult learners is the tendency to view learners through the western-centric, culturally homogenous lens that does not represent the broader reality of adults who participate in learning activities (Lee, 2003). This perspective of andragogy is critical in helping to understand the potential characteristics of adult learners, while also recognizing the limitations of the model and assessing its usefulness for diverse populations. Andragogy encompasses many practices common in adult education, such as self-directed

learning, experiential learning, and transformative learning (Kawalilak & Groen, 2020). These forms of education are particularly relevant to the health professions as these disciplines are populated with lifelong learning practices common to requirements for advanced degrees and ongoing professional development.

Professional Development

In addition to the learning that occurs in various aspects of adult life, professional education is a specific form of adult learning with functions related to employment and careers (Lindeman, 1926). Also referred to as work-based learning, this area of adult learning is particularly embedded in the relationships between people and the social processes of the context in which it takes place (Evans et al., 2011). Professional development, professional education, and professional learning are incorporated into various industries and professional roles to develop new skills, recertify, regulate practice, maintain accountability, and demonstrate ongoing competency (Curran et al., 2019).

Professional development has been a topic of interest for decades, predominantly in relation to teacher education and professional development of educators and education professionals (Borko, 2004; Guskey, 2002). Educational research on this topic has provided insight into the characteristics of effective professional development (Guskey, 2003; Penuel et al., 2007), development models suitable for a variety of professions (Dall'Alba & Sandberg, 2006), and professional development as an authentic learning experience (Webster-Wright, 2009). Core features of effective professional development include focusing on content, promoting active learning, fostering coherence, and assessing outcomes (Garet et al., 2001). Advances in professional education have also emphasized flexibility and learner control to select content of interest and relevance to individual practice (Curran et al., 2019). Professional

development has been inextricably linked to change, particularly in relation to individual attitudes and perceptions but also as a factor in larger scale organizational change (Guskey, 2002). Professional education in healthcare has historical roots that can be traced back to the transformation of medical education in the early 1900s to improve the knowledge and skills of physicians (Cervero & Daley, 2016).

Professional Development in the Health Professions. Professional development in the health professions has been defined as “specialized training, formal education, and/or advanced professional learning intended to help clinicians, teachers, researchers, and administrators improve their professional knowledge, competence, skill, and effectiveness” (Hilty et al., 2019, p. 338). Also called continuing professional development, the activities associated with learning in this context are designed to advance, update, or develop new knowledge related to current practices, skills, knowledge, or attitudes (Peck et al., 2000). When the focus is on physicians as learners, the term “continuing medical education” is also widely used (Hilty et al., 2019).

Several other related terms have been used interchangeably in the literature to describe the ongoing development of healthcare and health research professionals, including capacity strengthening, capacity building, and capacity development. Capacity building often refers to generating skills or processes “from the ground up” or when starting “from scratch” (Fullan, 2007), though arguably the existing expertise of current professionals negates the blank slate definition. Critical of professional development as consisting of too many activities and not enough learning, Fullan (2007) described capacity building as providing new competencies, new resources, and new motivations. Capacity strengthening is often used as an extension of or the next stage of capacity building, when describing initiatives that involve whole communities or a variety of stakeholders, often in an international development context (Block & Mills, 2003).

Capacity development is defined as the process of individual and institutional development which leads to higher levels of skills and greater ability to perform useful tasks (Trostle, 1992). Due to the ambiguity of the capacity-oriented language, and the wealth of educational research in professional development, this will be the term used in this study. Professional development in the health professions aligns strongly with the constructivist approach, which aims to develop ways of reasoning and problem solving that are increasingly complex and are situated within a particular content area or field of practice (Hilty et al., 2019).

The goals of professional development in the health professions are often related to improved practice and patient outcomes (Peck et al., 2000; Wallace & May, 2016), though the clinical impact of professional development activities are not consistently measured or reported in the literature (Opperman et al., 2018). Common educational interventions that address the need for professional development in health professions include a variety of training initiatives, from individual workshops to longer-term programs that provide researchers with the knowledge and skills to perform useful research (Golenko, et al., 2012; Wallace & May, 2016). Professional development has been reported as more effective when activities are interactive, offer practice opportunities, include multiple exposures, are linked with practical implications, and include a reflective component (Wallace & May, 2016). While building capacity in a system, community, or institution, there are key elements to consider at each level, including the individual, team, institution/organization, and system-level needs (Cooke, 2005). While each of these levels must be considered in overall change management, the focus for the educational change in my study is on the individual, while exploring their experience as part of a social ecosystem within the healthcare environment. Over time, the development of well-trained professionals to sustain

practice improvements may contribute to larger organizational changes in the environments in which they work (Crisp et al., 2000).

Organizational changes and practice improvements are often governed by change management principles at the organizational level and focus on influencing the behaviour of those working within these environments. Change theory and behaviour are relevant to adult learning, particularly in professional contexts where behaviour is generally changed, rather than created. As professionals continue to develop expertise in their area, they may also exhibit deep-seated routines and practices that may be challenging to revise even in light of new advancements; for this reason, change theory and an understanding of behaviour is an important consideration.

Change Theory and Behaviour

The goal of a change event is often to affect a specific change in behaviour, yet the ability of individuals to adapt is incredibly complex (Bronfenbrenner, 1970). Behavioural change theories related to health often focus on individuals and communities as patients and the need for change in behaviour to improve health or prevent disease (Burke et al., 2009). In examination of health-related behaviour change, Sanders Thompson (2009) suggested that there are no sufficient behaviour change theories that adequately integrate individual and group behaviour with social and environmental context. For health professionals, the focus of behaviour change is not in relation to individual health but in response to workplace pressures and ongoing innovation (Bransford et al., 2000). Behaviour change in the health professions domain is increasingly complex as it involves more than individual values and behaviours, but is intricately shaped by the social, political, and organizational environment of the larger health ecosystem.

The healthcare environment, as well as individual professions and disciplines, have frequently been implicated in collective resistance to changes in scope or behaviour (Apramian et al., 2015), particularly in relation to information technologies (Lluch, 2011). Barriers to adoption of new information technologies include the structure of healthcare organizations and decision processes that manage the change event (Lluch, 2011). However, education may be a source or catalyst for change (Fullan, 2007). In any healthcare implementation or intervention, Bero et al. (1998) suggested that educational materials and didactic educational activities had little or no effect; multifaceted interventions, outreach, and interactive learning opportunities demonstrated significant improvements in effectiveness.

The value social constructivism places on context and environment also plays a prominent role in change theory. Context is a complex yet integral part of the mechanisms that shape the way individuals experience the phenomenon of study (Maxwell, 2004). The learning sciences as a discipline is focused on understanding the complex variables at play and encourage research that seeks to understand the contextual dynamics to advance theory-in-context (Barab, 2014). Barab (2014) recommended the lens in which learning sciences research takes place within a broad ecosystem that is inherently part of the study and not separate from it. As learners are expected to adopt new behaviours, it is important to consider the context in which the individual is situated (Lave & Wenger, 1991); in this case, learners are an agent among a team, a department, a profession, and an institution. Learning cannot be viewed as a solitary action or activity, but as a part of a greater intersection amongst people and the system in which they operate (Bronfenbrenner, 1977).

Education, in the form of professional development, is often used to change practices, ideas, or attitudes in favour of new ones that provide solutions to existing problems or prevent

additional issues arising from current practices (Denis et al., 2015). diSessa (2014) insisted that the prior knowledge described by Vygotsky (1978) is a resource rather than a barrier and that individuals are willing to adapt their beliefs as part of the process of learning. Acknowledging the ability of learners to process new information and broaden their knowledge base is an important step in understanding learners and their ability to change (diSessa, 2014). Educators and change leaders, especially those in professional disciplines, must be cognizant of the change-related fatigue that exists for many learners (Fullan, 2007). Distress over repetitive change may present as burnout or anxiety and can derail an otherwise sound educational design (Fullan, 2007).

The adult learning and change theory topics briefly reviewed here provide insight into the population of interest and capture some of the key concepts relevant to the adoption of innovation in the healthcare environment. To further understand the context of learning related to this research study, an overview of the content of the learning, data science and technologies, will now be provided.

Advanced Data Technologies in Healthcare

As early as the 1960s, studies on the use of AI and data-related advances have been published in the health and medical fields (Warner et al., 1961). Since these early advances, the potential for use of data-related technologies in healthcare has been focused on several topics as observed in the literature, including the significance and value of AI in healthcare, the impact on the role of health professionals, the need for training and development, and the discussion of key issues such as ethics, bias, and quality. This brief review will highlight these areas of focus and situate the current discourse in relation to the study.

The use of AI in healthcare has only become a possibility in recent decades because of the increasing availability of data as well as advances in analytic methods (Pepito & Locsin, 2019). The focus of artificial intelligence in healthcare is frequently on machine learning because of the ability of this technique to make accurate predictions using large sources of data (Sidey-Gibbons & Sidey-Gibbons, 2019). These predictive capabilities, when applied to healthcare, can be designed to anticipate potential negative outcomes, such as medication interactions or readmission to hospital (Amarasingham et al., 2014).

The potential uses of AI in the healthcare environment has been widely discussed. Most often, the potential impact of AI in specific healthcare examples falls under the machine learning branch of AI, which is focused on making predictions through highly trained algorithms (Shameer et al., 2018; Sidey-Gibbons & Sidey-Gibbons, 2019). The potential for machine learning in healthcare is often touted as being capable of broad improvements, such as improving the delivery and effectiveness of care (Kolachalama & Garg, 2018), enhancing medical research (Sidey-Gibbons & Sidey-Gibbons, 2019), and fundamentally disrupting clinical practice (Scott et al., 2019). Specifically, AI is anticipated to improve the accuracy of imaging and diagnostics (Ahuja, 2019), reduce diagnostic errors (Rajkomar et al., 2019), increase productivity (Ahuja, 2019), decrease processing or waiting times (Krittawong, 2018), and provide predictive capabilities that can improve decision making (Scott et al., 2019), potentially preventing some complications, conditions, or mitigating risks (Ahuja, 2019). The ability to use large amounts of data to better understand individual patient risks or predict outcomes is generally referred to as precision medicine.

Precision Medicine

The implementation of machine learning in healthcare is often associated with the trend towards precision medicine (Dorado-Diaz et al., 2019; Mesko, 2017). In precision medicine, advanced data technologies provide the ability to base medical treatments on individual patient characteristics as analyzed in comparison with large data sets (Ahuja, 2019). Current medical practice is based on general practice guidelines, which inform the care of a patient based on the best available evidence for overall conditions or diseases. Precision medicine provides the capability to individualize care, replacing these broad guidelines (Ahuja, 2019). Powered by machine learning, precision medicine can identify, for instance, ideal or exact medication doses on an individual basis, or determine which genetic mutation drives a certain cancer (Ahuja, 2019). Predictive analytics are far superior to human capacity in identifying medical risks due to the ability to base recommendations on huge sources of data that are unrealistic for an individual practitioner to use (Krittanawong, 2018).

Clinical Impact

The key areas of medicine poised to benefit from the initial implementation of machine learning include establishment of prognosis, interpretation of images, and accuracy of diagnosis (Obermeyer & Emanuel, 2016; Scott et al., 2019). Additional advantages of machine learning include improved therapeutic effectiveness, increased efficiencies in routine tasks, and faster laboratory or investigative results, all of which have the potential to improve patient outcomes (Scott et al., 2019). Other improvements in care include a reduction in errors, such as errors in prescribing or unintentional overdoses (Rajkomar et al., 2019). Expedited diagnosis through machine learning could improve efficiencies for patients in rural areas or who are far from a

specialist or specialized facility while administrative strategies may improve documentation and clinical workflows (Rajkomar et al., 2019).

Reduction of errors and minimizing risks are critical aspects of patient safety. Scholars have been calling attention to diagnostic errors as a critical aspect of patient safety, suggesting that precision medicine is an important step (Newman-Toker & Pronovost, 2009). Hospital systems most often work in a shift-based model, meaning that a single practitioner is unlikely to follow a patient through the trajectory of their care; advanced data tools may provide added patient safety and continuity of care by identifying risks and potential complications that a single practitioner may not detect (Char et al., 2018).

Professional Roles

The idea of machines replacing a variety of roles, in healthcare and other industries, has been a topic of science fiction and scholarly discourse alike. Concerns that physicians, particularly radiologists, will be replaced by AI-based systems have been noted (Ahuja, 2019; Obermeyer & Emanuel, 2016), though most agree that the impact is much more likely to be experienced as an augmentation or alteration of professional roles in healthcare (Krittanawong, 2018; Schwartz, 1970). AI may provide the opportunity to optimize and improve what physicians already do, rather than offering a replacement of the care provider. Advanced technologies may also have the potential to reduce physician burnout that is often linked to administrative and clerical overload (Ahuja, 2019). From this perspective, AI-based systems may provide a supportive role that allows professionals to focus on high-level thinking, critical decision-making, and patient interaction (Ahuja, 2019).

Decades ago, as technological advancements increased, Schwartz (1970) warned of threats to professional values and identity, loss of self-esteem, loss of status, and social

ramifications. While much of the literature speaks primarily to the physician role, Robert (2019) insisted that the need for nurses will also remain, but that technology will change how nurses spend their time and how care is delivered. While both advantages and disadvantages are likely, it may require a re-definition of roles to provide clarity and support to medical professionals as they adapt and adjust to changes in technologies (Pepito & Locsin, 2019; Yu et al., 2018).

Training and Development

Training and development are not often the focus of discourse on AI and machine learning in healthcare but have been recognized as an important aspect in the implementation of these tools (Lluch, 2011). Sidey-Gibbons and Sidey-Gibbons (2019) acknowledged that the enthusiasm for AI in healthcare has not been matched by increases in training or development to advance the knowledge and skills of practitioners. It has been suggested that “clinicians are ill-prepared” for big data approaches in precision medicine (Krumholz, 2014, p. 1164). Clinicians untrained in the use of machine learning techniques and interpretation may not be able to meaningfully use the data in practice and decision-making (Mesko, 2017; Rajkomar et al., 2019). In addition to training, Krumholz (2014) insisted that clinicians’ attitudes and mindsets will need to adjust to become familiar with evidence generated from these new technologies.

Best practice for the development of machine learning models points towards the engagement of practitioners in model development. Mistrust of new technologies may stem from models that may be incorrect, therefore providing inaccurate information (Krumholz, 2014). To mitigate this potential issue, clinicians should be involved in the development of data tools and in determining how data generated from routine care can be used in automated processes (Rajkomar et al., 2019). Physicians who use machine learning ought to be educated about

technological design, the data sets used, and the limitations of the tool (Char et al., 2018; Rajkomar et al., 2019; Shameer et al., 2018).

Practical aspects of training may require focus on teaching concepts and encouraging familiarity with new tools without becoming overwhelmed by terminology and the underlying computer programming details (Kolachalama & Garg, 2018). Practical guides, including choosing the appropriate tool for a given task, as well as providing ample clinical examples, are key to effective instruction and learning (Kolachalama & Garg, 2018). Ultimately, it may be the responsibility of each medical professional to learn about AI technologies and how these tools can assist them in clinical practice (Ahuja, 2019). Failure to do so may not lead to physicians being replaced by robots, but simply by other physicians who have the skills to use the technology (Ahuja, 2019).

The evolution of medical education to prepare the next generation of clinicians as well as training current professionals will be critical to any implementation initiative in AI and machine learning (Bilimoria et al., 2019; Dwivedi et al., 2019; Yu et al., 2018). Learning approaches are often not widely considered for implementation of AI, yet informal dissemination, in addition to formal education, may be critical for successful adoption (Robert, 2019). This speaks to the relevance of social ecosystems in the learning process as well as the change processes in the health system environment. Vanneste et al. (2013) advocated for high quality education that is designed to suit the context or setting. Training groups, such as those organized by need, setting, or type of training needed, can help to provide the appropriate resources and support (Vanneste et al., 2013). Learners should be followed through the post-learning phase and through implementation to provide support and evaluate outcomes of the learning (Vanneste et al., 2013).

Considerations for Integration of Advanced Technologies in Practice

The integration of new technologies into the healthcare system and practice is complex. Rapid innovation has made it difficult for the medical community to keep up with the pace of changing technologies (Lai & Mamzer, 2020). Despite the rapid advancements of AI, few technologies are translated into clinical practice (Liyanage et al., 2019). A contributing factor to the lag of adoption of technologies may be the variety of opinions on how AI should be used in practice (Liyanage et al., 2019). Other factors may include resistance to change or lack of belief that AI will address critical factors in patient care (Apramian et al., 2015). Chen and Asch (2017) suggested that social determinants of health may be more predictive for hospital readmissions than clinical data alone, demonstrating some of the contrary beliefs of AI as the focus of medicine moving forward. The primary issues with AI in professional health and medical practice raised in the literature include ethical considerations, biases, and data quality.

Ethics of Data Science. Some of the more prominent concerns about data-related technologies are those that fall under ethical considerations, such as bias, data privacy, custodianship, and cybersecurity (Lai & Mamzer, 2020). As the use of AI increases, so do corresponding threats to the privacy of health-related data (Redmore, 2019, as cited in Ahuja, 2019). While some scholars insist it is AI users who are responsible for addressing these issues (Ahuja, 2019), questions have been raised about who is liable for the protection and accuracy of AI programs (Price et al., 2019).

Healthcare institutions and systems must make it a priority to balance privacy and regulatory requirements with the intention to use the large data sets that are needed to develop and improve machine learning models (Rajkomar et al., 2019). Responsible use of machine learning also overlaps with the responsibility to provide safe care. Improper use of machine

learning could lead to improper interpretation and care; poor patient outcomes related to the use of AI and machine learning must now be addressed in medical ethics and policies (Char et al., 2018).

Bias in Big Data and AI. Machine learning models can only work according to how they have been designed. Biases in data may include “race, ethnicity, language, socio-economic status, and sexual preference” (Scott et al., 2019, p. 204). The research ecosystem has a history of skewed data that frequently underrepresents entire populations, which means that the data already errs toward misrepresentation and bias (Char et al., 2018). If biases exist in routine care, prior research results, and existing data, then the models that are taught to recognize patterns on this data would make biased predictions (Sidey-Gibbons & Sidey-Gibbons, 2019). The significant risk of bias is inherent in the ways in which it can be incorporated into a data training set and propagated into a validation set (Liyanage et al., 2019). Essentially, an algorithm may inherit human biases that are ingrained in the data set or the model itself (Char et al., 2018).

Subtle discrimination that is inherent in the healthcare system may be difficult to identify in routinely collected data, making it more difficult to prevent a machine learning model from learning and mirroring this bias (Char, et al., 2018). Machine learning systems need to be designed and used with acknowledgement of these biases in mind, including protections to monitor for and address bias (Rajkomar, et al., 2019). Training is critical to ensure that practitioners understand the ways the models have been developed to ensure they do not rely too heavily on tools that may have biased data or models (Sidey-Gibbons & Sidey-Gibbons, 2019).

In addition to the inherent biases ingrained in routinely collected data and from overrepresented populations in health research, other forms of bias may also be present. Char et al. (2018) warned of AI designs that would favour desired metrics and positive reporting data

rather than improved outcomes or quality of care. The importance of multiple practitioners and designers at all levels of the healthcare system understanding the models and how they work is critical to reducing the possibility of intentional or unintentional bias in these technologies.

Data Quality. Health systems have been collecting massive amounts of data since electronic records were first used; in some jurisdictions, this has been in place for years or decades. The integration of electronic records has often proved frustrating for practitioners due to “administrative documentation, clunky user interfaces, increased time spent entering data, and new opportunities for medical errors” (Rajkomar et al., 2019, p. 1353). The difficulties brought on through the inputting of clinical data create significant consequences in the use of this data for AI techniques. The lack of high-quality data in these large clinical data sets is concerning (Rajkomar et al., 2019). Poor data quality may include entries that are incomplete, incorrect, poorly labelled, or inadequately entered, which will lead to errors in the machine learning design (Scott et al., 2019). These inaccuracies in clinical data, if used in prediction models, may put patients at risk.

Adding to the issue of data quality is the issue of custodianship of different data sets. In most jurisdictions, including western Canada, data are siloed in various electronic health records systems, such as billing records, imaging records, inpatient records, or pharmacy records (Rajkomar et al., 2019). Use of quality data may require access to multiple data sets and monitoring for differences or inconsistencies that may hinder the development of machine learning models. Data analysts and practitioners must be aware of the data available — and what is not available — as well as how these data sets may align to provide what is needed for machine learning development.

Selected Studies in Health Technology

The literature about advanced data technologies and their implementation in healthcare primarily consists of opinion pieces, editorials, and commentaries, with research studies surfacing within the past few years. Much of what was written in commentaries was prospective and provided an optimistic account of what is possible for AI in healthcare, how it might be achieved, and any potential issues or challenges. Studies on the integration of AI into a specific clinical environment with the contextual focus on the nuances of that specialty have not been included for critical review in this section as they were found to be highly specific to a disease area or clinical practice with little discussion of generalizable or transferable aspects of the change procedures, training, or overall implementation involved. Five studies were identified as representative of available studies and most relevant to this research topic, as each one examined or explored areas such as clinician awareness of AI use (Liyanage et al., 2019), health professionals' perceptions of and perspectives on AI (Lai & Mamzer, 2020; Sarwar et al., 2019), processes for AI innovations (Apell & Eriksson, 2021), and adoption of an AI-based decision support tool (Fan et al., 2018). In this section, I will briefly review each article to highlight the current discourse from the literature.

In a 2019 study conducted by Sarwar et al., physician perspectives on the integration of AI into diagnostic pathology were examined. The goal of this study was to understand the potential impact of AI technologies through surveys completed by nearly 500 pathologists from 54 countries (Sarwar et al., 2019). Excitement about and acceptance of AI was significant among respondents, who anticipated the clinical tool with optimism and expected high relevance to their practice (Sarwar et al., 2019). A common theme in the survey responses was the need for physician training, both in implementation of the clinical tool and in related topics, such as legal

implications (Sarwar et al., 2019). It was interesting to note that almost one quarter (23%) of respondents felt that training would not be necessary, indicating that they expected the technology would be intuitive to use and that they would not require any additional education (Sarwar et al., 2019). Despite this result, the authors recommended educational resources and conference topics in AI for physician education. While the authors recommended training, their specific recommendations do not appear to be based on evidence or study results and may provide a narrow scope of learning to address the significant task of AI implementation. It was also important to note that there was no indication in the study results as to how many of the survey respondents had actual experience with AI implementation in their professional practice. Considering the varied contexts of health systems across 54 countries, the results do not appear to relate to any practical or consistent AI implementation experience.

Liyanage et al. (2019) explored awareness of the uses of AI in primary care settings as part of a working group process to develop expectations for AI in primary care. Through a three-round Delphi study, 20, 12, and 8 respondents, respectively, were involved in each of the three rounds with a goal of developing consensus (Liyanage et al., 2019). The respondents prioritized the development of standards and guidelines in their responses (Liyanage et al., 2019), though there was little focus on individuals or system-wide needs or strategies to implement the guidelines or adhere to standards. The study sample was purposive, as it included only members of the working group (Liyanage et al., 2019). Despite the sample including participants from all over the world, no explanation was provided as to how these radically different healthcare contexts may have impacted individual responses or study findings. The lack of diverse perspectives may have been a limitation in this study. As members of the working group, it seems reasonable to consider that members have a similar and vested interest in AI for primary

care settings. Similarly, the goal of the process was consensus, not the general exploration or examination of individual and collective perspectives; critical dialogue or discourse was not presented. As in the Sarwar et al. (2019) study, it was not clear whether the respondents had any experience with AI in their primary care setting, instead exploring awareness of how it may be used. Despite the limitations, Liyanage et al. (2019) found that respondents expected AI to be useful in the primary care setting, but lacked clarity around how services may be provided, what decision support might be required, or how the implementation might take place.

A grounded theory study conducted in France in 2017–2018 by Lai and Mamzer (2020) reported more complex perceptions of AI from interviews conducted with health professionals. Forty interviews were conducted with health professionals with knowledge about or interest in AI in health; many participants had direct involvement in the AI industry (Lai & Mamzer, 2020). Grounded theory was used to analyze the interview data with the intent to develop theory about AI perceptions (Lai & Mamzer, 2020). The participants had concerns about AI in healthcare including lack of clarity about the notion of AI, concerns about the knowledge AI is developing, reality of international competition, and upheaval of the doctor-patient relationship (Lai & Mamzer, 2020).

An interesting part of the study design, in contrast to Sarwar et al. (2019) and Liyanage et al. (2019), was the focus of the population within one country, which provided some contextual consistency, while interviewing a variety of stakeholders to examine perspectives across differing roles in the health and AI industries. Lai and Mamzer (2020) reported significant themes raised by participants, including positive attitudes towards the adoption of AI, the importance of regulatory bodies, and the clarity needed regarding the responsibility of various stakeholders as AI integration progresses (Lai & Mamzer, 2020). This is one of the only studies

in the literature to explore the values and perceptions of stakeholders regarding AI technologies for healthcare in recent years, and it provided useful insight into significant issues that were expected to be prevalent in this research study as well. Of interest is the lack of discussion around how these tools might be integrated for optimal success and the learning, support, and change processes required to do so.

A Swedish study on processes for AI innovation in the healthcare sector took a unique approach by including the perspectives of individuals from AI technology companies as well as academia and healthcare (Apell & Eriksson, 2021). In this mixed methods case study, which used primarily interviews and published documents as data sources, researchers conducted a 3-phase study in which input from each group of participants helped to shape each subsequent phase of exploration (Apell & Eriksson, 2021). After an empirical analysis of the number of AI healthcare technology innovations in their environment, most were services innovations, such as decision support tools, however participants felt that service innovations were the most challenging to implement (Apell & Eriksson, 2021).

A useful design element of this study was the ability to compare the perspectives of those in healthcare and academia with those in industry, though most participants agreed that it is challenging to attract the necessary talent to innovate in the healthcare space as the challenges and barriers are well known (Apell & Eriksson, 2021). Despite the difficulties, participants recognized knowledge development and diffusion as a relative strength in healthcare, while resource mobilization, entrepreneurial experimentation, and system-wide synergies were felt to be lacking in most circumstances (Apell & Eriksson, 2021). The authors described the research as a case study, though the bounds of the case appeared to be broader than a methodologically aligned case study. Participants had a variety of roles, worked at numerous organizations, and

had different levels and types of involvement with AI technologies. Most notably, there seemed to be no consistent technology, innovation, or project that aligned or grounded the topic and therefore some hesitation might arise when comparing the perspectives of individual participants as they may have had remarkably different contextual aspects and experiences in mind.

A study investigating adoption of an AI-based medical diagnosis support system (AIMDSS) was conducted in China to understand the factors that impact acceptance and adoption of the technology (Fan et al., 2018). AIMDSS was developed to provide support to physicians for diagnosis and early detection of cancers and other common diseases, to assist in decision-making, and potentially reduce errors (Fan et al., 2018). The authors used the Unified Theory of Acceptance and Use of Technology (UTAUT) model to examine user acceptance of the technology in a population of 191 health professionals in China through online and paper questionnaires (Fan et al., 2018). The results show interesting relationships between factors and the impact on behavioural intention, such as trust of the technology in relation to the burden of health and well-being related to professional decision-making (Fan et al., 2018). This study provided a different perspective and approach to understanding the adoption of technology through statistically significant impact and relationships between factors. Some of the significant findings in this study may need to be critically examined before applying to external contexts as health systems across countries vary greatly and thus, the individual behaviours and ecosystem in which people practice may play a significant role in individual perceptions. Another key detail of this study in relation to my doctoral research is the focus on behavioural intention rather than behavioural change, as they are not yet in the final stage to evaluate actual use.

The literature reviewed demonstrated recent efforts to understand the complex health system and the potential, actual, and experiential perspectives on integrating advanced

technologies in healthcare. The novel intersection of this topic is demonstrated in the studies by Sarwar et al. (2019), Liyanage et al. (2019), and Lai and Mamzer (2020), as the explorations in these recent examples are still prospective in nature and not reflective of an actual change event or a planned implementation. This illustrates how early the healthcare industry is in this technological evolution and how much we collectively need to learn to optimize the practical opportunities as well as inform the theoretical foundations and scientific discourse. The work of Apell and Eriksson (2021) added some practical elements to the discussion from the literature, though the primary source of innovation was service innovations which, while complex and difficult to implement, have some nuanced differences with advanced technological innovations. It is important to note these differences, though much can be gained from understanding service innovation projects.

While the Fan et al. (2018) study was the closest in nature to the work for my doctoral study, the key aspect noted was the study of behavioural *intention* rather than behavioural *change*. Nonetheless, the study participants noted similar factors to those from the work of Apell and Eriksson (2021), such as the importance of trusting the innovation, understanding the change in professional role, and the challenges of resource allocation and difficulties working across discordant systems. Adding to this small body of literature was important to gain a broader understanding of the relevant topic areas, therefore additional sources were sought and outlined in the next section.

Adoption and Implementation Science

As my doctoral study progressed, the difficulty of locating a substantial body of knowledge from existing AI studies called for further exploration into associated topics that were critical for a broader understanding. This also reflected an amendment to the study design as outlined in Chapter Three. Additional searches revealed a number of adoption of innovation studies (e.g., Garfield et al., 2021; Palm & Persson Fischier, 2021) that were not specifically AI-focused (though some digital or technical aspect was required for inclusion in this section) as well as articles on implementation science in the healthcare innovation space.

Implementation science, defined as the field of study that supports the integration of research evidence into practice (Eccles & Mittman, 2006), is meant to guide the implementation of interventions in a strategic manner that reflects the contextual needs of the change and the setting (Powell et al., 2017). Interventions that are found to be effective in implementation studies may still fail to provide meaningful outcomes for patients based on the significant variation in health care contexts (Damschroder et al., 2009). While research in this field continues to evolve, it often remains unclear which strategies are most effective at the various levels, from clinician, team, organization, system, or policy levels, as they exist within exceedingly complex contexts (Powell et al., 2017).

Seven additional studies were found to provide relevant insight into implementation of innovation with some form of technical or advanced product or service design, despite the innovations lacking a focus on AI. The selected studies included exploring management perspectives on successful innovation implementation (Palm & Persson Fischier, 2021), implementation of digital reporting tools (Urquhart et al., 2015), exploring the perspectives of healthcare entrepreneurs (Janssen et al., 2013), an empirical evaluation of an adoption of EMR

study (Garfield et al., 2021), explorations of factors of acceptance and resistance to new technologies (Desveaux et al., 2019; Safi et al., 2018), and an examination of diffusion of innovation among cardiologists using agent-based computational models (Borracci et al., 2018).

Using a qualitative action research approach, Palm and Persson Fischier (2021) identified enabling factors for successful innovation implementation according to the perspectives of individuals in management roles. The authors identified a gap between the generation of a novel idea and the implementation of the resulting innovation and conducted this study to explore how this gap might be addressed (Palm & Persson Fischier, 2021). Their study design included a participatory action process that focused on a case study, a healthcare project in Sweden, that involved 24 managers and 30 employees who participated in focus groups and interviews (Palm & Persson Fischier, 2021). From the analysis, the authors identified key areas of consideration for adoption and implementation of healthcare innovations, such as organizational culture, organizational structure, and resource availability (Palm & Persson Fischier, 2021). Potential limitations to the study included the identification of employee participants by their own managers, demonstrating a potential source of bias despite criteria for selection. Additional limitations to the context of the study, in relation to this dissertation, are that the innovations addressed were not necessarily data-related or technology-based, therefore a wide interpretation of the term innovation must be applied, though the results are found to be relevant in many areas despite the ambiguous nature of a potential innovation.

Urquhart et al. (2015) explored the implementation of a technological innovation used for a new reporting tool in a case study focused on cancer care in Nova Scotia. Urquhart et al. (2015) agreed that uptake of new tools in healthcare is complex, requires extended periods of time to implement, and involves processes that are poorly understood. The case study involved two

projects that implemented separate reporting tools, one for a colon cancer prevention program and another for breast and colon cancer surgery; each involved integration from hospital technology systems to patient registration and medical records (Urquhart et al., 2015). Researchers used semi-structured interviews with key informants as the primary data collection with triangulation from a variety of project documents (Urquhart et al., 2015). Urquhart et al. (2015) included a large sample size for interviews, with 19 participants for the prevention program and 21 participants for the surgical project. Participants from both cases encountered a range of challenges, including lack of clarity about organizational roles and governance, disparate IT systems across care sites, confusion about policy and privacy legislation, and resistance at all levels of the healthcare system (Urquhart et al., 2015). The challenges identified in this study are remarkably similar to those of other digital technologies and innovations, indicating that perhaps the barriers are consistent despite the nature of the technological innovation itself.

In the Dutch healthcare setting, Janssen et al. (2013) took a different approach to understanding innovation by focusing on healthcare entrepreneurs. Through semi-structured interviews with 14 participants, Janssen et al. (2013) sought to understand the influence of entrepreneurs on the healthcare system as well as the inverse relationship of how the healthcare system influenced entrepreneurial strategies. There are contextual differences to consider when innovation is attempting to enter the system from an external source versus the attempts of those within the system (e.g., internal decisions or improvements). Janssen et al. (2013) found that healthcare entrepreneurs viewed the system as resistant to change, focused on problems instead of solutions, were hesitant to leverage external solutions, and were slow to progress through innovative pathways and lacking in the transparency that is needed to create supportive and

complementary partnerships. The perspectives from entrepreneurs are not unlike the views from other studies and authors which focus on those within the system. However, there are valuable insights and recommendations to consider from the entrepreneurial perspective, such as integrating different aspects of the supply chain, combining purposes (e.g., prevention and care) in a more strategic way, and increasing productivity (Janssen et al., 2013).

Garfield et al. (2021) took a novel approach to a study on the adoption of an EMR system, attempting to empirically validate the relationship of health information technology with an organization's capability to support innovation. This study was extremely relevant in the areas of organizational infrastructure. However, it was excluded from the literature review because of the nature of the innovation, an EMR implementation, fell outside the selected criteria. Garfield et al. (2021) described the adoption of an EMR system as a form of technological innovation; arguably, an EMR is a necessary evolution of health records in the form of digitization and not a sufficient example of advanced data-related technologies. Much of the discussion that was presented by the authors was relevant to the general understanding of processes and systems and the nature of adoption within healthcare environments (Garfield et al., 2021). In particular, Garfield et al. (2021) emphasized the importance of balance between tensions, such as those between flexibility and control in a healthcare organization, catalyzing a need for better coordination and cooperation across teams and departments.

In interviews with healthcare stakeholders and patients, Safi et al. (2018) suggested a novel method to identify factors associated with acceptance of and resistance to implementation of new digital health technologies. In this German study, participant interview data was triangulated with significant secondary data sources, including specialist magazines and websites (Safi et al., 2018). While little was described of the specific eHealth technology, findings were

consistent with similar studies. Experiences of resistance were associated with fear of technology as a form of control, loss of autonomy, and hesitancy about the resulting changes to the nature of patient-provider relationships (Safi et al., 2018). Features of acceptance included an appreciation for the broader availability of information for decision-making and time-savings that could benefit care interactions (Safi et al., 2018). Further description of the eHealth technology and the descriptions of secondary sources would have provided additional context to interpret the findings; the authors also explored three different models and frameworks in relation to the findings which were interpreted as having a lack clarity and focus.

A Canadian study was found to provide distinct relevance to the doctoral topic through an exploration of the challenges and opportunities of implementing digital health innovation in Ontario (Desveaux et al., 2019). The authors chose a constructivist paradigm to guide semi-structured interviews with 10 senior leadership members across multiple organizations. While again, the authors provided little context or description as to what constitutes a digital health innovation in the study, participants discussed valuable aspects of policy, change management, and institutional culture as important for realizing the potential of advanced innovations in the health system (Desveaux et al., 2019). The analysis of interview data was illustrated in a model that provided both conceptual oversight and pragmatic guidance for those in leadership as well as those within the system itself (Desveaux et al., 2019). The sample size was consistent and purposive of senior leadership only; a potential avenue for further exploration and comparison could involve management, staff, and project teams that work within the represented organizations. It was difficult to ascertain whether the participants, while working in various organizations, had been involved any of the same digital health innovation projects or if personal experiences were of a broad or disparate nature.

The final study selected was included due to the focus on cardiologists as the population of interest as this aligns with the doctoral study. Borracci et al. (2018) employed a unique method to produce empirical demonstration of the diffusion process among cardiologists. Based on survey data collected from cardiologists, the authors developed agent-based computational modeling (ABM) to model the diffusion of medical innovations. ABM provided insight into the collective behaviour as demonstrated through the interaction of multiple variables among the cardiologist population surveyed (Borracci et al., 2018). Results were consistent with qualitative studies with similar goals and purposes, demonstrating the importance of network connections, physician autonomy, leadership input, and pragmatic aspects such as affordability (Borracci et al., 2018). The complex ABM used may be limited by an empirical approach to understanding human behaviour. Similarly, a reader's understanding of complex ABM may hinder the usability of the results or limit the addition of this body of knowledge to the relevant literature that often come from social disciplines or qualitative methodology.

These seven studies provided valuable insight into the contextual factors relevant to implementing and adopting innovative projects in the healthcare space. Because the nature of this topic is so specific, the addition of studies focused on the adoption of innovation provides helpful breadth of knowledge to consider not only the type of innovation, but the common characteristics and pathways that ought to be considered to support adoption. The variety of study populations, from healthcare entrepreneurs to cardiologists, also offers unique insights on the perspectives of different actors in the healthcare and innovation environment.

Additional Sources

Six additional articles helped to frame and explore my topic to a degree that merit mention and include the following: a conceptual framework developed by Flessa and Huebner (2021); a scoping review by Cote-Boileau et al. (2019); a literature review on adoption or implementation of innovation (Allen et al., 2017); a program report on implementation in a health network (Walker et al., 2020); a program evaluation on health IT adoption (Dorr et al., 2018); and a viewpoint article exploring theories, models, and frameworks for implementation of innovation in healthcare (Sarkies et al., 2021). Each of these additional sources will be briefly explored, highlighting the relevance and value to my topic.

First, in the development of a conceptual framework for innovations in healthcare, Flessa and Huebner (2021) explored the challenges and requirements for successful adoption and diffusion of innovations. An analysis of barriers and promoters of innovation highlighted common issues of costs, infrastructure and leadership requirements; the resulting framework outlined the necessary aspects for an innovation to be successfully adopted inside an organization (Flessa & Huebner, 2021).

Second, a scoping review by Cote-Boileau et al. (2019) explored an understudied aspect of the impact of innovation and the ability to achieve health system transformation. In a review of 24 papers, the authors developed a framework intended to guide health system professionals through the process of implementation with a focus on five core areas to support successful adoption (Cote-Boileau et al., 2019). The five areas of focus included: (a) the why, (b) the perceived value and feasibility, (c) what people currently do, (d) creating dialogue between policy and delivery, and (e) supporting capacity building (Cote-Boileau et al., 2019).

Third, an extensive literature review by Allen et al. (2017) provided a historical and comprehensive lens of the landscape of adoption or implementation of innovation at the organizational level of the healthcare environment. While the 40-year span of literature provides significant context and breadth, the nature of innovations would have changed drastically during this time period, so reader interpretation of the relevance of the types of innovation may be necessary. Despite the evolution in innovations over time, Allen et al. (2017) found a lack of clarity in the definitions of constructs associated with adoption, implementation, and innovation. Furthermore, Allen et al. (2017) described inconsistent use of theory and found few validated measures in this space. However, valuable insights and recommendations included the perspective on implementation climate and readiness for implementation at the organizational levels, including learning climate, relative priority, tension for change, leadership engagement, and resource mobilization (Allen et al., 2017).

Fourth, a health network evaluation of the ability to support spread of innovation at scale was explored by Walker et al. (2020). This British study, with an internal focus on their own health system network organization, sought to explore how to better facilitate successful implementation in the clinical setting (Walker et al., 2020). Using their own case examples and supporting literature, the authors applied frameworks of innovation to successful programs within their network. While internally focused and contextually specific, the case examples demonstrated some of the realities of implementation, noting the messiness and non-linear pathways that abound (Walker et al., 2020). While limited as research and more useful when interpreted as its own evaluation and case example, the authors highlighted the connectivity between individuals, teams, and organizations that are essential to realize success (Walker et al., 2020).

Fifth, a program evaluation paper, focused on three project examples, explored how the diffusion of innovation spreads through a system (Dorr et al., 2018). The technology targeted as part of the project examples in this American study included an EHR, registry, and automated provider alerts (Dorr et al., 2018). The evaluations were conducted independently with differing methods, limiting the comparative potential. While this format is less useful from a formal research perspective, the authors noted consistent findings related to adoption, data, and overcoming barriers. Project participants and outcomes demonstrated that adoption strategies were substantial yet sometimes insufficient, data were difficult to access and share, and technical assistance was often required to overcome complex barriers (Dorr et al., 2018). While the potential of the innovations was still embraced, Dorr et al. (2018) emphasized that enhanced collaboration with innovative communities would bolster these efforts.

Sixth, a viewpoint article by Sarkies et al. (2021) explored the variety of theories, models, and frameworks that have been applied to the study of implementation of innovations in the healthcare sector. All of the articles selected for review were from a single journal that focused on health organization and management and included 31 articles over a 5-year period. The findings from this review highlighted the collective behaviours and activities required for implementation science to function appropriately as an interdependent and interactive field of work (Sarkies et al., 2021). Sarkies et al. (2021) suggested that the design of successful and comprehensive strategies for implementation of new innovations requires considering more than simply barriers and facilitators to change. Interdisciplinary collaboration, focused on pragmatic approaches and common goals, requires in-depth understanding of the social behaviours and complex processes involved to meet the goals of changing practice and improving patient outcomes (Sarkies et al., 2021).

The three sections above, selected studies in health technology, adoption and implementation, and additional sources, together provided the foundation for my doctoral study. In a relatively new and evolving field, such as AI implementation in healthcare, it is unsurprising that literature is scarce, as these projects are generally new and take years to develop, test, validate, implement, and evaluate. The inclusion of additional non-AI studies as well as relevant additional sources helped to bridge the gap related to this topic and provided a more holistic lens. Leveraging existing knowledge on innovation and implementation provided a breadth of expertise that is relevant and well-aligned with the doctoral study, offering an additional level of insight into the analysis and findings discussion presented in Chapters Four and Five.

Positioning the Study

Despite the importance numerous scholars have placed on intention, perceptions, and attitudes, the studies reviewed for my dissertation span a range of innovations, methodologies, and contexts. The value of my research study includes adding to the limited literature that explored an actual change event as it was experienced by members of the target population. The unique perspective of actual experience through the integration process may provide new insight into the many layers of individual and collective learning, adoption, and integration.

Many studies on AI and machine learning in healthcare are highly specific to analytic development and design, such as algorithm development and validation or modelling design (Gulshan et al., 2016; Shameer et al., 2018; Son et al., 2020). The education-focused studies that do exist tend to focus on medical education for the next generation of physicians and practitioners, as educators grapple with how to incorporate these topics into academic curriculums (Kolachalama & Garg, 2018; Wartman & Combs, 2019). The major challenge of

how to address changes in practice and support practitioners to learn new techniques must be addressed.

Theoretical Framework: Constructivism

A theoretical framework is the frame or underlying structure of a study consisting of concepts or theories that inform the work (Maxwell, 2012). A theoretical framework is intended to be taken up by a researcher and applied within the context of the work (Dewey, 1910).

Constructivism is described as the foundation through which learners interpret content and develop knowledge that is personal and individualistic through the incorporation of essential events, objects, and perspectives from their own world view (Jonassen et al., 1995). Essentially, learners build new knowledge on the foundation of what they already know (Vygotsky, 1997). These perspectives shape the way in which the learner actively develops new knowledge from a foundation of prior knowledge and experience (Dewey, 1916; Piaget, 1973). Dewey (1916) emphasized that learning interactions often take place between the learner and his or her environment. Scholars such as Piaget and Vygotsky share the notion that the ideas and beliefs that individuals, and groups of individuals, have about an issue shapes the social reality of that issue (Carey et al., 2015).

The constructivist framework was relevant for this study as the frame of learning was highly focused on the learner and the context in which they have experienced, interpreted, and applied new knowledge as part of a change event. Through the lens of constructivist theory, learners are provided with opportunities to build on previous knowledge and incorporate the environment in relation to the learning that takes place (Barab & Squire, 2004; Sawyer, 2014). This is particularly relevant for adult learners in a professional setting, such as health professionals, because of the high level of previous knowledge already held in professional roles.

It is also critical to examine the environment in which learning takes place due to the nuanced and contextual nature of health professions disciplines, including the culture, identity, and common practices that also take place within a larger ecosystem (Bang, 2015). Brown et al. (1989) proposed that learners' physical and social spaces are essential to understanding how learning occurs. The constructivist approach provides a lens through which to view the social constructs, professional cultures, and collective behaviours that are shaped by the social setting of the healthcare environment.

Constructivism can be further examined as either social or cognitive constructivism. Cognitivist models of constructivism, informed by Piaget (1972), align with pedagogical approaches such as distance education, in which interaction between learners is generally minimal (Anderson & Dron, 2011). Social constructivism, however, considers knowledge to be constructed through social interactions that are integral to developing understanding (Brown & Adler, 2008). As health professionals continuously work in teams, across professions, and within a large and complex health ecosystem, it is from the social constructivist lens that this study was designed.

Social Constructivism

A key concept in social constructivism is the Zone of Proximal Development, which suggests that when learners acquire new knowledge, it is linked to prior knowledge and interaction with others in their community (Vygotsky, 1978). The way individuals think, learn, and perceive new knowledge is interdependent with their environment and sculpted by the activities, social structures, and processes of their cultural community (Bang, 2015). The linkages from prior knowledge to new ideas create a space in which learners can process new information in the context of their current understanding (Taylor & Hamdy, 2013). In clinical

and health research environments, the application of new knowledge to the practical aspects of professional practice is crucial.

Social theories of learning are also strongly linked to concepts of context and community (Choi & Hannafin, 1995). Lave and Wenger (1991) developed the concept of communities of practice, a model common in the health professions environment, to develop knowledge amongst groups of professionals interested in similar topics or working in similar areas. The way in which a learner engages with new learning, and the community which they inhabit, is shaped by the context of the environment (Durning & Artino, 2011). This is also known as situated cognition, which is based on three main assumptions about learning as:

- a social activity
- structured by the tools available in specific situations
- influenced by the learning environment or setting (Wilson, 1993).

Situated cognition also promotes meaningful learning by prioritizing the applicability of learning to real-world situations (Choi & Hannafin, 1995). This is particularly relevant for the health professionals who must learn new tools and tasks with a high level of success due to the nature of work with patients and the responsibility to ensure patient safety.

According to McDermott (1993), learning does not exist within an individual but resides in the cultural activities and practices of groups and communities. Social theories of learning have also been described as learning that occurs across, and amongst, groups of people as they participate in activities of specific cultural relevance (Robbins, 2005). The health professions and healthcare environment exist within professional disciplines, departments, and institutions with ingrained cultural activities, practices, tools, and norms (Brown et al., 1989), which creates a complex yet fascinating setting in which to explore learning in context. To understand this

culture and context, it is important to understand the population of health professionals from an educational perspective as adult learners.

Conceptual Framework

A conceptual framework provides a broader understanding of a phenomenon by offering a new way of looking at a problem (Bloomberg & Volpe, 2019). Numerous models have been developed to examine acceptance of emerging technologies and adoption of innovation, although the literature has primarily focused on adoption of electronic health records or similar information or communication technologies (Cresswell & Sheikh, 2013; Lluch, 2011). While this body of literature is important from an organizational change management perspective, the considerations for adoption of more advanced AI technologies may require models that incorporate a different perspective. The Technology Acceptance Model (TAM) was designed to predict user acceptance and identify design issues before implementation (Dillon & Morris, 1996). The Theory of Planned Behavior (TPB) was developed to predict individual behaviour (Sparks & Shepherd, 1992). These models focus primarily on behavioural intentions and perceived behavioural control (Koul & Eydgahi, 2017). These models have been widely used and have demonstrated significant value in revealing differences between the stages of intention and actual change (Koul & Eydgahi, 2017). The models are primarily used in work settings across a variety of industries, though they have also been used to predict consumer behaviour (Lu et al., 2005).

While the behaviour-focused models are helpful for understanding individual beliefs and the connection of intention to behaviour, they are limited in incorporating other factors, such as organizational culture and change management. The model used in the Fan et al. (2018) study, the UTAUT model, warranted consideration. Developed by Venkatesh et al. (2003), the value

this validated model offers is the integration of eight theories into a single comprehensive model. The UTAUT model provides a useful framework to help examine the factors that either hinder or enable the adoption and use of technology based on four main constructs: performance expectancy, effort expectancy, social influence, and facilitating conditions (Hennington & Janz, 2007; Williams et al., 2015). As the UTAUT model was not designed specifically for the healthcare system, users are urged to consider contexts carefully rather than blindly applying the model (Vanneste et al., 2013). Other constraints of using this model include the design as an empirical construct to statistically represent the relationship between factors. While this doctoral research study is not empirical, the factors identified in the UTAUT model can assist in guiding the lines of inquiry in the case study to ensure the exploration encompasses these important factors. A comprehensive review of the use of UTAUT in available literature concluded that the work conducted so far using the UTAUT model may be best used to help direct fruitful lines of inquiry and facilitate the consideration of theoretical and methodological approaches (Williams et al, 2015).

Diffusion of Innovation

Rogers' (1983) Diffusion of Innovation model provided the most relevant framework to examine how innovations spread across and within an organization (Cresswell & Sheikh, 2013). Developed by Rogers (1983), a sociologist, the Diffusion of Innovation model was initially developed to examine agricultural innovation; it provided a sequence of events during the process of adaption to, or diffusion of, innovation over time (Robertson, 1967). Used commonly in marketing, the model is illustrated by a traditional bell curve under which individuals can be classified into one of the following five categories related to their uptake of innovation: innovators, early adopters, early majority, late majority, and laggards (Robertson, 1967).

Robertson (1967) described the model as best suited for innovations that have been demonstrably better than existing practices and where it is simply a matter of time before the majority of the target population adopts the innovation. The Diffusion of Innovation model also identifies influencing factors in the acceptance of innovation, including influential role models, compatibility with existing values, alignment with existing needs, and the degree of complexity of the change (Sanson-Fisher, 2004).

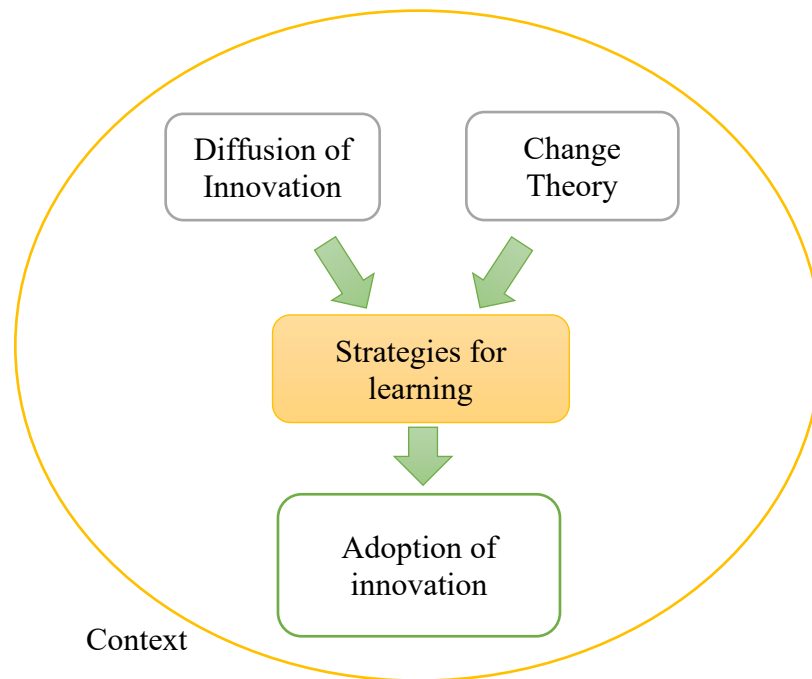
The widely used Diffusion of Innovation model considers important aspects of the change process, such as the steps in decision-making and the social context (Sanson-Fisher, 2004), which also strongly aligns with the social emphasis found in the social constructivist perspective. According to Rogers (1983), there are five elements that contribute to the adoption of innovation: relative advantage, compatibility, complexity, trialability, and observability. Each of these elements offers valuable insight into the factors that may influence individuals in the uptake of new technologies, such as the perceived improvement an innovation provides over a previous practice (relative advantage), how difficult a technology is to use (complexity), and the degree to which the innovation can be tested or revised (trialability) (Sanson-Fisher, 2004). The Diffusion of Innovation model also offers recommendations and strategies for the style of communication to convey information to the target population (Bero et al., 1998), steps to take in the decision-making process (Rogers, 1983), and insights into the effects of the social context (Sanson-Fisher, 2004).

The Diffusion of Innovation model was used in health contexts as early as the 1950s in a study of innovation among physicians (Coleman et al., 1957) to better understand adoption of new behaviours in clinical practice (Sanson-Fisher, 2004). The application of the Diffusion of Innovation model has also been used to understand the research to practice gap and why some

innovations are adopted while others with strong scientific basis remain underused (Denis et al., 2002). The application of diffusion patterns to the healthcare context provided a useful framework to inform aspects of the study. Denis et al. (2002) viewed the “process of diffusion as an interaction between two entities” (p. 65), an innovation with key characteristics, and an adopting system. The adopting system is made up of actors, each possessing a variety of values, interests, and power dependencies (Denis et al. 2002). The importance of this adopting system is part of the context of the health ecosystem in which a change takes place and is part of the exploration of this research study. The Diffusion of Innovation model and change theory provided a basis for the consideration of the change event related to advanced data technologies.

Creating a Conceptual Framework

Using Rogers’ (1983) Diffusion of Innovation model and change theory guided the exploration of my dissertation topic. The experiences of healthcare professionals provided insight into the learning strategies that took place and how these concepts contributed to the end result: the adoption of innovation. All of this occurs within a specific contextual environment, represented in Figure 1, as the basis for the model and was developed to guide this exploration.

Figure 1*Conceptual Model for Adoption of Innovation*

Drawing from the literature, this conceptual framework demonstrates the key concepts and their relationship with each other. The conceptual framework has informed and guided my initial research design with a visual that illustrates how I have considered each of these topics to inform the study. Rogers' (1983) Diffusion of Innovation and change theory are central components that helped to guide the exploration of the experiences of participants and understand how teams and organizations manage implementation and adoption efforts. The central action and focus are the learning strategies, an area that I focused on in the study design in the hope of gaining clarity on the priorities and successful activities that assist teams, stakeholders, and the target audience in adopting the new technology. This was also considered to be a focal point in the study because it may be a more flexible or amenable aspect of the work considering that Diffusion of Innovation steps and change theory aspects in the larger

organizational infrastructure may be more difficult to influence. Potentially, what is gained or learned about effective learning strategies from study participants could be more readily adopted in practice than factors that require institutional input or approval. The end result of these concepts, the final component of the process, was thought to be the successful adoption by users.

The outer boundary, labelled as context, was considered the broader influence of environment, both internal to the institutions as well as the external environment, which can affect everything in the healthcare and academic spaces. This overarching structure is meant to show that the environment can affect everything in this space, including the enactment of diffusion or change strategies within an organization, even though the concepts themselves are built on structured models and longstanding theories, respectively. Potential factors in the context or environment may include changes in leadership, funding, government, or policy that can have substantial direct or indirect impact on staff, projects, and pathways for success.

Summary

In this chapter, I have introduced the key topics relevant to the area of study, primarily adult learning and data science, as well as specific sub-topics within these domains. A review of relevant literature provided background and contextual foundations for the study, such as AI innovations, non-AI innovations, and implementation science in healthcare. The study was then positioned in relation to the selected philosophical and theoretical constructs and contextualized with the proposed conceptual framework. The conceptual framework will be revisited in Chapter Five. In the next chapter, I outline the research design for the study.

Chapter Three: Research Design

In this chapter, I outline the philosophical underpinnings of the research which align with the theoretical framework of social constructivism, the lens through which I reviewed the relevant literature and concepts related to this study. I then provide detail of the methodology and methods, including the recruitment strategy, sample, instruments, data collection, and analysis procedures that were employed for this project. The key elements of rigour, ethical considerations, limitations, and delimitations relevant for this study are also presented.

Paradigmatic Orientation

To ensure the integrity and clarity of a research study, it is crucial to identify and acknowledge the worldview of the researcher and the philosophical assumptions that inform the work. In this section, I outline my own ontological and epistemological stances and the ways in which these perspectives have shaped the study. Paradigms can be characterized by their ontology, epistemology, and methodology that represents a worldview (Denzin & Lincoln, 2001; Patton, 2015) and guided the perspective of this research. The philosophical assumptions that guided the research questions posed in this doctoral project are a critical element in the study design, as I considered how each individual makes sense of the world, including my own role as the researcher in shaping my approach (Creswell, 2013).

The tension between paradigmatic orientations is one that I experienced as part of my hybridized, boundary-crossing professional role. As a registered nurse working in a medical and research environment, my philosophical views are located in the murky waters between the positivist and interpretivist traditions. In my clinical practice, I valued multiple forms of data to clearly understand a given scenario. For example, laboratory results (objective data) or descriptive symptoms (subjective data) alone paint only one picture; together they provide a

more holistic view of the patient and their health concerns. Ultimately, I found myself driven by the individual experience of a condition to provide the context to better understand the empirical evidence.

A relativist perspective considers that there are multiple realities, or perhaps multiple experiences of reality, and multiple meanings (Lincoln et al., 2011) that can be attributed to experiences. The relativist position explains truth as relevant to context, that individual experiences in the world shape the truth as they know it (Denzin & Lincoln, 2001). This worldview guides my own experience in practice and in research as I consider individual perceptions of reality as intrinsic to life experiences. This ontological foundation aligns with the interpretivist paradigm as understanding truth as socially constructed and acknowledging that there are multiple realities (Merriam & Tisdell, 2016). It is through this lens that multiple perspectives of a change event may be quite different and can inform a more holistic understanding of the collective experience.

Epistemology, a branch of philosophy, is the study of the nature of knowledge and is guided by one's ontology; the relativist approach to truth in turn relates to knowledge as relative, co-constructed, and interpreted by individuals (Denzin & Lincoln, 2001). Qualitative research is based on this epistemological stance, insisting that "knowledge is constructed by people in an ongoing fashion as they engage in and make meaning of an activity, experience, or phenomenon (Merriam & Tisdell, 2016, p. 23). The guiding epistemology for this study is constructivism, which suggests that individuals experience and interpret the world individually in a way that is shaped by events, objects, and perspectives (Jonassen, 1991). Social constructivism is an underlying theoretical perspective that guides qualitative research as the researcher seeks to understand the meaning of a phenomenon by those who experience it as part of the social

framework of their world (Merriam & Tisdell, 2016). The underpinnings of this study assume that meanings are subjective and arise from a social and historical space (Creswell, 2013). The study was designed to collect and analyze individual experiences; however, the socially constructed world of health professions is expected to play a role in the way change events are experienced. This will be acknowledged and explored throughout the study.

The brief paradigmatic overview reviewed here is designed to situate my study as one that is guided by constructivism. This perspective reflects my own worldviews and the belief that there are multiple realities experienced by individuals as shaped by their own prior knowledge and experiences in the world. I also recognize, in my approach to this study, that the healthcare environment is filled with social norms, cultural practices, and historically-situated realities and this is also acknowledged through the constructivist lens. A qualitative methodology allows for an interpretivist approach through which meanings will be interpreted from the experiences of individuals in the target population.

Methodology

A methodology refers to how one goes about finding out knowledge as a strategic approach (Wainright, 1997). In the following section, I outline my choice of a qualitative case study methodology. This methodology allowed me to explore my research question and seek to understand a complex phenomenon in a real-world setting (Harrison et al., 2017).

Case Study

Case study methodology is defined as “an in-depth description and analysis of a bounded system” (Merriam, 2009, p. 40). It is an ideal strategy “when ‘how’ or ‘why’ questions are being posed, when the investigator has little control over events, and when the focus is on contemporary phenomenon within some real-life context” (Yin, 2003, p. 1). Case study

methodology uses a variety of evidence to understand the activity within its own context and is particularly useful in obtaining deep insights that may help to inform professional practice (Bloomberg & Volpe, 2018). This strongly aligns with the purpose of my study to explore the learning and adaptation related to advanced technologies within the healthcare and research context.

Denzin and Lincoln (2011) insisted that case studies are essentially qualitative, though the fluidity of the case study as methodology and method has been an ongoing evolution. My research employed case study as methodology that informed and shaped my study design (Hyett et al., 2014). Methodology provides the lens through which the study is to be viewed and guides decisions about the study; a method, then, is the procedures and techniques used (Mills & Birks, 2014). Case study methodology in health-related research has been described as a “bridge across paradigms” (Luck et al., 2006, p. 103), allowing philosophical foundations to inform the work, rather than alignment with a paradigm. The flexibility of employing case study in a way that best aligns with the philosophical foundations and discipline of the researcher allows for a case study to be intentionally designed for the context of a research problem (Flyvbjerg, 2011).

Case study as methodology is primarily informed by three seminal scholars: Stake (1995), who aligned case study with post-modernism; Merriam (2009), whose approach is rooted in constructivism; and Yin (2014), whose perspective embodied a realist, post-positivist approach. Merriam (2009) described case study as relying heavily on specificity and rich description. Descriptions ought to be explicit to demonstrate a holistic viewpoint (Hyett et al., 2014), including information about the physical, organizational, and political context (Stake, 1998). The goal is a contextual study that situates the phenomenon and participant experiences within a larger ecosystem (Priya, 2021); the ability to incorporate and examine organizational

and political contexts may be particularly relevant in the healthcare environment, where these conditions impose significant effects on health professionals.

Identifying features of the case study include the case study unit as a limited, bounded system (Merriam, 2009; Stake, 1995; Yin, 2014) and the use of multiple sources of data collection (Stake, 1995). A bounded system is classified as a single entity or unit around which there are defined boundaries (Smith, 1978). Clear descriptions of these boundaries are essential to communicating the setting and context in which the case takes place. In my study, the boundaries of the case are identified as health professionals in western Canada who have been involved with a specific cardiac registry project.

Merriam's (2009) approach to case study aligns with my own perspective as the researcher as well as the purpose of the proposed study. Alignment of epistemological and ontological perspectives are a critical step in the design of a study, from selection of the topic of interest to the way the research is carried out (Yazan, 2015). Merriam (2009) demonstrated a pragmatic approach to the constructivist perspective with emphasis on process-driven data collection and analysis, including stepwise procedures including conducting a literature review, crafting research questions, and purposive sampling (Yazan, 2015). The pragmatic approach proposed by Merriam (2009) ensures that the research is manageable, credible, and applicable. This chosen method supports credibility by following, documenting, and demonstrating that the processes were adhered to and allows others to follow the thought processes and steps that led to the analysis and findings. The case study approach for this research is descriptive, which is intended to create an end product that provides rich description of the phenomenon of study (Merriam, 2009). Multiple sources of data allow help to develop the rich case description and to support the research findings (Tellis, 1997). The use of multiple data sources was well suited for

my study in order to provide insight into the topic from the document review to add clarity and context during the exploration of individual experiences.

Challenges: Case Study as Methodology

There can be challenges when using a case study approach. For example, generalizability, often valued in empirical research, is not applicable to case study research and is not the goal of qualitative research (Merriam & Tisdell, 2016). While some may argue that the lack of generalizability is a limitation of case study methodology, it has also been emphasized that qualitative case study methodology simply offers a different type of data that is well suited for the purpose of contextual data that is specific to nuanced topics and would not benefit from a generalizable approach (Merriam & Tisdell, 2016).

Merriam (2009) also acknowledged limitations of case study methodology, including descriptions that may oversimplify a complex phenomenon as well as lengthy reports that may not offer the reader a clear grasp of the research. While this delicate balance poses a challenge, it can also be used as a guideline as the research moves into the phases of analysis and description. By being mindful of these potential concerns, this research was conducted in such a way as to minimize these challenges and provide descriptions that are rich and in-depth while presenting the findings with clarity.

The challenges of case study as a methodology itself are also anticipated, as this has been an area of disagreement among the research community. While the seminal authors of work on case study as a methodology have been discussed (Merriam, 2009; Stake, 1995; Yin, 2009), other scholars have been critical of case study described as a methodology (Wolcott, 1992). Creswell (2012) supported case study as a methodology as it provides a specific frame for how to go about studying a phenomenon. As with any research approach, case study itself is not

inherently problematic, but may be subject to poor implementation, inappropriate method selection, or ambiguous terminology that contributes to misunderstanding of the methodology (Bloomberg & Volpe, 2018; Harrison et al., 2017).

The work developed in this chapter attempts to both examine and justify the selection of case study methodology as the relevant approach for this research study.

Rationale for Case Study Methodology

While case study methodology has been widely used in educational research (Yazan, 2015), it has more recently gained traction in the health services research community. The relevance for case study methodology in health services research aligns with the goal to understand the complex nature of relationships, systems, and contexts (Sibbald et al., 2021). My case study is focused on the phenomenon of learning as support for change events related to advanced data-related technologies. An in-depth exploration took place through interviews where both exploratory and explanatory questions were pursued. Case study methodology aligned with the goals of my study as I focused on a concrete event (the cardiac registry project) that was contextually based and bounded by time and participant involvement.

Research Question

The research questions developed for this study, as posed in Chapter One, have evolved to explore the experiences of health professionals who have participated in a specific change event related to the integration of advanced data-related technologies. The areas of interest included key aspects from the literature review including change theory, learning strategies and conditions, behaviour change, and an examination of the environment and context in which the change took place.

Due to the coronavirus pandemic that influenced all facets of life and healthcare prior to the recruitment for this study, this research project was delayed. Upon resuming one year later, slight changes in the research questions were submitted to the ethics board (and subsequently approved) to address the pivot in target population, now focusing on the cardiac registry project team and collaborators across the two primary institutions, to avoid targeting frontline health professionals during the healthcare crisis. The updated research questions were:

- What are the conditions required to support successful adoption of data-related innovations in the health professions?
- What is the role of learning in supporting the adoption of data-related innovations?
- What were the experiences of team members and collaborators who played a role in an adoption of innovation change event?

Case Description

The focus of this case study is the design and implementation of a cardiac registry. The innovation involved in this case study is a demonstration of the types of data-related technologies that are new to the care and research environments. The project design involved patient-reported measures collected through innovative point-of-care technologies and propriety software applications. This data can then be linked to administrative and clinical data from the health system records and exported to a research computing environment for advanced development of predictive clinical tools through the testing and validation of algorithms for machine learning models.

Population and Sampling

The target population for the study were health professionals, including project staff, researcher collaborators, and institutional staff and leadership, with experience of a change event

related to advanced data technologies. The bounded system selected for the case study was intended to provide a sample of health professionals who had experience with the same change event related to the integration of advanced technologies used for healthcare practice and health research. The selection of a population within a bounded case ensured that the data collection is in close proximity to the situation of interest and possessed a grounding in the local context (Miles et al., 2014). By targeting a population who have experienced the same change event, this exploration provided an in-depth account of a singular change experience from multiple perspectives. The varied, in-depth perspectives from within the target population are intended to yield an understanding of the phenomenon of interest (Bloomberg & Volpe, 2016).

The sample selection for this study, as a common characteristic of qualitative research, was not random, but purposeful and relatively small (Merriam & Tisdell, 2016). Purposive sampling allows for understanding the special experiences of a particular group of people with a focus on specific, information-rich exploration (Patton, 2015); this aligns with the qualitative approach that seeks to understand a particular topic within a particular context. Purposeful, or purposive, sampling through the selected case study leadership and intermediary will allow willing participants to volunteer for an individual, semi-structured interview.

The sample for this study was research team members and staff, leadership, or administrative collaborators within a defined context, who played a role in the design or implementation of a specific cardiovascular data registry, as the unit of analysis. This group is characteristic of a case study because it is a particular, finite group of people that can be identified as a bounded system (Merriam, 2009). This population was selected to provide information on their experiences with the design and implementation of an innovation related to the integration of advanced data technologies. Miles et al. (2014) indicated that qualitative work

often uses smaller groups; the goal for qualitative interviewing is not a predicated sample size, but data saturation (Vasileiou et al., 2018).

Recruitment

Recruitment of participants took place between March and June 2022. Recruitment was facilitated by an intermediary who shared study information and the invitation to participate via email. Interested participants responded with their willingness to participate and indicated preferred contact details that allowed me to set up an interview. Efforts were made to gain diverse representation, such as a variety of professions, levels of experience, and self-described roles related the cardiac registry project (e.g., leadership, clinical care, research collaborator, institutional approval roles, etc.).

Recruitment challenges. Working through the project team intermediary was requested by the research ethics board as my professional role with the university was considered a potential conflict of interest. However, there were challenges in working through an intermediary, such as delays receiving project documents and significant delays in identifying relevant potential participants and sending out the initial recruitment email. Email reminders and offers of support were sent to the intermediary in numerous attempts to move the project forward, however most efforts were unsuccessful until the principal investigator of the cardiac registry project re-enforced the need for action. One participant, who volunteered to participate after receiving the invitation email and confirmed that they met the criteria of involvement with the cardiac registry project, ultimately had no direct knowledge of the project and opted to participate due to the nature of their professional role and the alignment with the overall topic of interest (adoption of innovation). This was not disclosed until the start of the interview, at which point I indicated that this was not a relevant role for the study, however the conversation did

proceed briefly in a general way (not following the script) regarding innovation in the healthcare system, though this transcript was largely irrelevant.

Data Collection and Analysis

Research methods are the techniques and procedures used to conduct a study (Mills & Birks, 2014). This study used multiple sources of data, with primary data collection through semi-structured interviews and subsequent document review. This approach allowed for a broader exploration of the topic within the bound unit, while exploring further contextual nuances and depth in providing a rich description of the case.

Data Collection

In the qualitative tradition, data often consists of quotations, descriptions, observations, and excerpts from interviews, documents, and interactions (Patton, 2015). The techniques employed for data collection must align with the theoretical orientation, study purpose, and sample (Merriam & Tisdell, 2016). The primary data sources for this study were the interviews with participants, along with documents (including historical project documents and related institutional strategy documents) and researcher field notes for further context.

Interviews. Interviewing is necessary when the information we seek cannot be observed but must be recalled and described by individuals who have experience with the issue, topic, or problem the study is designed to explore (Merriam & Tisdell, 2016). Semi-structured interviews were conducted to collect data for this study. Semi-structured interviews allowed for flexibility in the interview to capitalize on the unique experiences of each individual while providing consistent structure through a set of questions designed to guide the exploration (Merriam & Tisdell, 2016). Interviews were based on a semi-structured interview guide and lasted between 35 and 80 minutes. Interviews were recorded and transcribed for analysis.

The use of a virtual platform to conduct interviews, videoconferencing via Zoom, allowed greater convenience for participants who work at various sites across the region and for many participants who work in clinical environments which involves a variety of shift-related schedules. In-person meetings were not yet fully resumed at the time of data collection and the research site, located on a hospital campus, was often subject to outbreaks or closures related to the COVID-19 pandemic. Therefore, the virtual option added convenience and safety while providing visual connection for important nuances in conversation, such as facial expression and other non-verbal cues. Another added benefit was the ability to record interviews to aid in analyzing not only the verbal data, but to further explore or review nonverbal cues at a later time, though the field notes were sufficient and recordings were not reviewed. Potential limitations of the online interview format were the digital skills of participants, security of the interviews and recordings, and issues with internet bandwidth or other technological problems. None of these issues arose as participant technical skills were high, security of recordings were maintained as per institutional protocol, and virtual interviews were uninterrupted by extraneous issues, such as internet connectivity. Recorded interviews were downloaded from the videoconference platform and stored on a password-encrypted external hard drive.

Interviews were conducted to explore the contextual factors, politics, barriers, and infrastructure that contributed to success (or lack of success) for the adoption of innovation and implementation of advanced technologies associated with the cardiac registry project. In qualitative work, it is important to ask well-designed, open-ended questions that can be followed up with probes and prompts for further detail (Merriam & Tisdell, 2016). These probing questions allowed for further exploration of topics raised by participants and provided opportunity for the researcher to seek clarity or further description (Seidman, 2013). The

questions focused more on experience/behaviour questions and opinion/value questions, and less on feelings and sensory questions as categorized by Patton (2015). Care was taken in the instrument design to avoid leading questions (Merriam & Tisdell, 2016) and questions with yes-or-no responses. Interview questions were carefully reviewed and piloted to ensure questions were of high quality to address the study topic. The interview guide was revised and approved for the changes in research questions and target population (see Appendix A).

Interviews continued until no new information was coming from the interview process. This redundancy, or saturation, indicated that maximum information has been collected (Lincoln & Guba, 1985). Merriam and Tisdell (2016) discussed saturation as a means of determining if the sample size, such as number of interviews or documents, was sufficient. While it cannot be predicted when saturation might occur, the goal was to gather enough data to answer the research questions posed (Merriam & Tisdell, 2016). It was expected that 10–15 interviews would be needed; in total, 16 interviews were conducted.

Documents. Project documents, reports, and websites, as available, were reviewed to provide historical context to the events of the design and implementation process. This information helped to situate the experiences of participants in relation to the broader project design, protocol, and plans as well as the institutional teams, policies, and supports relevant to the cardiac registry project. A brief summary of the selected documents is provided in Chapter Four. Field notes were also maintained during the data collection phase of this study, including documentation of nuances noted during the interviews. Every effort was made to create thorough field notes, including highly descriptive accounts of interviews and a reflective component to capture commentary as the interviews and analysis took place (Merriam & Tisdell, 2016).

Data Analysis

A key characteristic of qualitative research is the ongoing data analysis activities that can continue to inform subsequent data collection and analysis (Merriam & Tisdell, 2016; Miles et al., 2014). The goal of my data analysis was to “make sense out of the data” (Merriam & Tisdell, 2016, p. 202). The findings from my study are a product of sorting, coding, describing, and interpreting the data that was collected (Merriam & Tisdell, 2016).

A qualitative coding process was followed in the analysis of interview data. Qualitative coding involved creating a shorthand system to easily identify and retrieve pieces of data (Merriam & Tisdell, 2016) by capturing excerpts, words, or phrases as they related to a theme (Saldana, 2015). Coding also involved identifying segments and units of data that were heuristic and small enough to stand on their own (Lincoln & Guba, 1985). Coded pieces of data were then constantly compared with one another and organized into categories (Merriam & Tisdell, 2016). The creation of categories and delegation of units of text among the categories was an inductive process as pieces of text were clustered together, continuing to assess and examine these categories and clusters as analysis proceeded (Merriam & Tisdell, 2016).

Interview Data. The interview data included field notes (including reflections on each interview), direct recordings, and interview transcripts which were coded and analyzed according to the process proposed by Miles et al. (2014). The analysis process involved cycles of codes and coding, first assigning meaning to excerpts of data and providing a descriptive label, then assigning the same label to other parts of the data or transcripts that also relate to that same code (Miles et al., 2014). A second level of coding sometimes involved assigning a “second-order tag” to provide further detail or enrich the original entry; this is also referred to as sub-coding (Miles et al., 2014, p. 85). The second cycle of coding involved patterns; excerpts or data passages were

grouped together according to the descriptive labels, or categories, assigned in the first cycle (Miles et al., 2014). This allowed me to organize the data from the first coding cycle into a more meaningful format (Miles et al., 2014).

Initially, each transcript was reviewed with key statements highlighted for further review. Notes were often made in the margins, using comment tools in MS Word to identify key areas of further thought, link to relevant field notes, or cue for cross-reference with the document resources. Then, a separate table was created to list all significant statements from each transcript, with a column for coding and for additional notes. This analysis process is demonstrated via the excerpt provided in Table 1.

Table 1

Excerpt from Key Statement Document

P#	Line #	Participant Quotes - Key Statements	Coding	Notes
3	36, 62	“There were a lot of new elements for me... I learn how to use it as I go”	Learning by trial and error	Clinical context for use of tool
3	122–124	“...the scope of the data that's being collected, including the patient reported outcomes part is... is very important. And is kind of, I think, key to its success. And very novel, I've not seen that anywhere else”	Design, strategy - Novelty	Level of success related to novelty of idea
3	154–156	“...other users within the Institute, maybe could have taken more advantage of this. And I'm not sure how that could have happened. You know, a lot of it has to do with just socialization of the, you know, of the... of the registry.”	Adoption - socialization	Design of project for socialization, behaviour change, adoption
3	159–161	“I think to start with you had to build it, it had to work before you could kind of start expanding it. And that took time, but that was very successful and those who use it, I think have used it very, very well and had a lot of success with it.”	Design, evolution	Demonstrate value and function before broadening scope
3	169–171	“...there was work done to publicize it, socialize it and you know, there was rounds, presentations given... [institute] communications and department communications”	Learning by awareness, traditional approaches	
3	171–173	“...most of its use has been kind of the organic type, those who kind of closest to it, or work with it, those who are closest to it, know of it, know its strengths the best.”	Awareness, organic reach	

Once the tables of key statements, coding, and notes had been developed for each interview transcript, the coding entries were reviewed and compiled by potential categories and broader themes. Original transcripts were reviewed for clarity as needed. A master spreadsheet was then compiled to locate all key statements by both participant number and category/theme assigned. A final table was then populated by theme and category with supporting statements from all participants. This stage of the analysis process was demonstrated with an excerpt from the working documents, illustrated in Table 2.

Table 2

Excerpt of Key Participant Statements by Theme and Category

Key Themes	Category	Sub-Categories	Elements	Participant Quotes - Key Statements
People	Champions	Main champion Other champions	Characteristics / qualities Vision / purpose Motivation	“Open-minded” (P3) “Very driven, has vision” (P4) “He had a prototype and a vision” (P6) “The reason we met with the right people” (P4) “Pivotal to have AHS champions that understand the work” (P10) “Champion had vision and endless energy” (P10) “Unwilling to stop at barriers, persistence and determination” (P12) “Need principled, passionate, persistent leadership” (P13) “Personality to engage others” (P13) “He believed in it and was convincing” (P13)
	Teams	Project teams Organizational service / support teams	Dynamics / qualities	“Supportive people and ... team made it all happen” (P10) “Flexible and willing to accept work-in-progress” (P12) “Need problem solvers and leadership that respects their team” (P13) “Team are fantastic collaborators” (P14)

The final stage of compilation and analysis was used to develop the thematic map for the findings (see Appendix B).

Two interview transcripts were shared with the doctoral supervisor and independently reviewed. Comparisons of initial coding were then reviewed together with no discrepancies noted. I processed the qualitative data manually, with processes and file management strategies that helped to manage the volume of data and ensure clarity and organization throughout the analysis phase. Any discrepancies or issues during this process would have been reviewed with the project supervisor and explored further for clarification.

At times during the analysis process, it was important to step back from the work and consider my own biases, how pre-conceived ideas might be affecting the analysis process, and how my position might have influenced the process (Merriam & Tisdell, 2016). My professional role did not feel like a conflict with the study in any way, but the close alignment with my professional work and the work of the cardiac registry project was consistently acknowledged and considered. While I interpreted this as a benefit in the deeper understanding of this type of innovation in the local environment, there may be aspects of the work that would be difficult to isolate from what might have been interpreted or understood if one was able to explore the case study independent of this knowledge. Towards the end of the analysis process, the process became largely deductive (Merriam & Tisdell, 2016). The final product is a narrative account of the data, observations, and field notes, organized by themes and categories and presented in a narrative, descriptive format in Chapter Four.

Document Analysis. Project documentation, as available, was collected to provide further context of the intent and actual implementation of the change event. Publicly available information, located on institutional websites, was retrieved while additional project and protocol

documentation were requested from the project manager. For documentation, a holistic interpretation was used, meaning that each was viewed to identify themes and categories (Miles et al., 2014). Document data were analyzed in a similar process to analysis of interview transcripts by grouping topics or themes and clusters in an iterative coding process. The results of the document analysis were a moderate resource for triangulating the data from individual interviews but were highly valuable for supplementing individual perspectives with pragmatic project and institutional context.

Integrity of the Study

The integrity of a qualitative research study is demonstrated through rigour. Rigour is derived from “the researcher’s presence, the nature of the interaction between researcher and participants, the triangulation of data, the interpretation of perceptions, and rich, thick description” (Merriam & Tisdell, 2016, p. 192). Morse (2011) described methodological integrity as a key component of the rigour and credibility of qualitative studies. The establishment of rigour in qualitative research is guided by the principles of trustworthiness, including dependability, credibility, transferability, and confirmability (Lincoln & Guba, 1985). It is the responsibility of the researcher to demonstrate the ways in which the study addresses the issues of rigour (Koch, 1996) and was addressed at each stage of the study by attending to the recommendations for each aspect of rigour.

Dependability

The dependability of a study is indicated by the accuracy of the data collection tools and methods and the clarity of processes used to collect, analyze, and interpret this data (Bloomberg & Volpe, 2016). This also involves providing “enough detail to show that the author’s conclusion ‘makes sense’” (Firestone, 1987, p. 19). Dependability, or reliability, involves all

aspects of the study, including how the study was conceptualized, the collection, analysis and interpretation of data, and the way the findings are presented (Merriam & Tisdell, 2016).

Dependability is also concerned with how a study perspective is aligned with the philosophical assumptions of the chosen paradigm (Merriam & Tisdell, 2016). Qualitative case study work is not expected or intended to be directly replicable as it relates strongly to individual experiences within a specific time and place in the world. However, the transparency of the processes undertaken can be illustrated by an audit trail which can allow others to authenticate the findings (Merriam & Tisdell, 2016).

To demonstrate dependability and reduce the possibility for bias, I have provided a chain of evidence illustrating as much information as possible about the journey from project design to transcript coding and analysis, and organization of the dissertation to allow the reader to follow the steps through the research study. I have also reflected, documented, and been transparent about my own position in relation to the case study and to the research in an attempt to demonstrate how my experiences, position, and assumptions have impacted this work.

Credibility

The credibility of a study is demonstrated by research findings that are congruent with reality and are related to the purpose and context of the research itself (Maxwell, 2012; Merriam & Tisdell, 2016). Throughout the study process I made every effort to provide clarity in the results and discussion by providing the details, descriptions, and context of the case as it unfolded in that moment in time, rather than as an assumption of an objective reality. I employed regular check-ins to acknowledge my own biases and documented accounts of this throughout the work, an approach that has been acknowledged to support the credibility of qualitative

studies. The piloting and testing of the survey questionnaire, particularly for wording and clarity, may also lend credibility to the instrument used.

In qualitative research, establishing credibility can also be achieved using multiple sources of data, including cross-checking data collected through different means (Merriam & Tisdell, 2016), such as interview data from different people (Creswell, 2002), or following up with interviewees after data analysis (Merriam & Tisdell, 2016). This final strategy, known as member checking or respondent validation, allows the researcher to ensure that they have analyzed the interview data accurately by presenting the preliminary findings to the participants who were interviewed (Creswell, 2002; Merriam & Tisdell, 2016). To do this, I communicated with participants via email and provided the interview transcript as well as the key statement document for review, inviting any feedback or corrections; no participant issues or corrections were communicated. Independent data analysis with cross-checking for consistency can also be an important tool in establishing credibility (Patton, 2015); this was done with the doctoral supervisor using the first four interview transcripts. The independent findings were quite consistent when cross-checked and helpful discussion ensued about choice of language for thematic coding and categories; the outputs of this discussion were applied to the remaining interview transcript analysis. Cross-checking interview data with the document analysis was also helpful in providing a broader view of the project design and institutional regulations that bound much of this case as well as provided direction for the design and implementation of the cardiac registry project itself.

Transferability

Transferability is the ability to apply the study findings to other contexts that may be meaningful and applicable to other audiences (Sandelowski, 1996). Qualitative and case study

work is not intended to be directly transferable, as the philosophical underpinnings and methodology is designed to address a particular problem in context for a specific population. However, the clear reporting of contextual factors and study findings may be determined to be helpful or relevant for readers in consideration of their own contextual interests and determine whether the insights from this study may be relevant (Merriam & Tisdell, 2016).

I have presented the findings in as much detail as was considered relevant and attempted thorough descriptions when possible. The nature of project and data-related topics often leads to more pragmatic discussions which can be challenging when attempting to demonstrate rich documentation. In addition, due to issues of confidentiality, some contextual descriptions have been necessarily omitted to ensure the privacy of the participants. In particular, many participants are the only individuals in their role or department and as such would be identifiable if further contextual descriptions were added. Ultimately, the pragmatic nature of much of the discussions was viewed as a strength as similar challenges are often experienced in the healthcare field and the descriptions provided may aid the reader in transferring some of these lessons to similar contexts.

Limitations

There are limitations to the use of case study as a methodology. Case study methodology involves collection and analysis of multiple data sources, which often includes document review as well as common techniques such as interview data (Crowe et al., 2011; Merriam & Tisdale, 2016). However, the data available for analysis as part of my case study was less than anticipated. Project team members and the PI stated that there were many internal project documents that could be shared, however few were provided. The limited amount of

documentation available for analysis was considered a limitation, though additional publicly available document sources were added to provide further contextual depth.

The conduct of interviews also introduces limitations. According to Merriam and Tisdale (2016), the potential for success of an interview is impacted by the interaction between interviewer and participant as well as the skill of the interviewer. As a novice researcher, I have to consider that a more experienced interviewer may have been more attuned to the nuances of the interview, such as being responsive to opportunities for thoughtful prompts and potentially extracting more from the participants than a less experienced interviewer. Brinkmann (2018) pointed out that interviews offer inherent limitations as they are partial to the researcher who guides and directs the dialogue based on the topic that they wish to pursue. Other authors noted that participant nature varies greatly, and individuals are not equally perceptive, descriptive, or articulate about their experiences (Bloomberg & Volpe, 2019). A potential mitigating strategy may have been a second round of interviews; this would have allowed time for additional reflection and crafting of suitable follow-up questions which could have lessened the impact of the lack of interviewing experience. A second round of interviews could have also provided more depth of exploration by completing a first round of analysis and then returning to participants for further descriptions, perspectives, and clarity.

The limitations experienced in the conduct of this study involved several external influences as well, primarily the COVID-19 pandemic. The COVID-19 pandemic, which became a global health emergency in March 2020, significantly impacted this study due to the professional nature of the potential participants and the impact of the pandemic on the healthcare environment. After a successful candidacy in Fall 2020, recruitment was set to begin in January 2021; discussion with my doctoral supervisor and the cardiac registry project principal

investigator at that time determined that the intended timeline for recruitment was unrealistic. At that time, healthcare professionals were inundated with the impact of the pandemic on their work, departments, and institutions, as well as personal impacts of stress and even burnout. It was determined that reaching out to healthcare professionals at that time was untenable and the study was put on hold and a formal leave of absence was submitted to the university for the 2021 calendar year.

The pandemic and recruitment delay also catalyzed a pivot in the intended recruitment sample. As frontline healthcare professionals and clinicians bore much of the impact of the pandemic for a long period of time (and to the time of writing, in many ways), it was decided that the cardiac registry project would be explored through the perspectives of stakeholders rather than the clinicians who used the project outputs. The stakeholders targeted for this recruitment were those involved in the design, planning, approvals, or implementation at the project level, such as staff, leadership, project teams, or approvers at both relevant institutions (academic and clinical) in addition to any external stakeholders (such as vendors or collaborators). The resulting potential participant pool now focused more on those at administrative, project, and leadership levels rather than frontline clinical care providers. While not technically a limitation, this pivot is acknowledged as one that deviated slightly from the initial proposal, but still provided rich feedback and perspective while respecting the nature of the extenuating factors that affected those in frontline roles.

The timeline delay is a more tangible limitation as there are several factors that may have impacted the study, primarily the delay and gap in researcher momentum and the extended recall bias for participants. Every effort was made to stay close to the topic during the leave of absence and review all documentation and relevant materials prior to the start of interviewing as a means

of refreshing the topic and re-establishing the momentum that had been interrupted. In addition, this also meant that the time since participants' involvement with the cardiac registry project may have also been longer than it would have been initially; recall bias based on time passed must be acknowledged. Efforts were made in the interviews to begin with the nature of involvement with the cardiac registry project, as well as acknowledging the timeline and any individual thoughts on recollection of the events and their contribution, while exploring any awareness of how those recollections and perspectives may have changed over time.

Delimitations

Delimitations are imposed by the researcher to capture the boundaries and scope of the research project (Bloomberg & Volpe, 2018). The delimitations for this study included: 1) narrowing of the topic; 2) boundaries of the unit and case study selection; and 3) multidisciplinary participants from both clinical and research spaces. First, the conceptual boundaries of this study included narrowing the topic of focus and excluding potential alternative approaches to select study parameters that would not only address the research question but that were feasible within the doctoral program guidelines. While the overall topic has remained constant, with narrowing and specificity during the doctoral course work, the case study selection involved a delimiting process to determine the most appropriate case for the topic.

Second, a variety of other case study samples could have been pursued, however the selection of this case reflects the interprofessional nature of the question and was characteristic of the phenomenon of interest in a real-world setting. This project and the innovation it produced demonstrated many facets of the topic of interest, such as the learning that took place and the implementation challenges and successes. As few projects had achieved implementation and sustainability in the local environment, this case selection was a suitable fit for the study.

Third, the bounded unit of analysis was delimited to restrict participants specific to professionals involved in the case as the unit of study. It is an important feature of the study to target professionals involved in both research and clinical practice and allows for a variety of perspectives of project collaborators or stakeholders that have played a role in the same change event. The study is delimited to the phenomenon described, specifically the learning, implementation, and practice changes associated with new information technologies in the healthcare environment.

Ethical Considerations

Researchers must have a complete understanding of the ethical considerations relevant to collecting data for educational research and consider the potential impact on participants (Bloomberg & Volpe, 2016; Creswell, 2012). This study was guided by the Tri-Council Policy Statement (TCPS 2): Ethical Conduct for Research Involving Humans Course on Research Ethics which outlines the ethical considerations for research involving human subjects. The study abided by the ethics review standards of the University of Calgary and all study documents, materials, and instruments were submitted for review of the Conjoint Faculties Research Ethics Board (CFREB). When amendments were made to the target population, and subsequently the data collection tool to ensure relevant questions were asked, these changes were submitted to the CFREB, and approval was provided before the study re-convened.

Informed Consent

Each potential participant was provided with full information about the study through a formal recruitment package. Informed consent was completely voluntary with every effort to minimize any potential interpretation of coercion based on my own employment with the academic organization. As an employee of one of the institutions of study, it was important to

note that I had no formal power-based relationships with any potential participant of the study. Researchers, project staff, administrators, and leadership members are formally employed through the larger regional university or healthcare organization and therefore any potential power issue or perception of coercion is minimal. Potential participants had the ability to exercise full autonomy in their decision to participate. Participants were required to provide signed consent and acknowledge review of the study documents prior to participating in the interview. An additional section was included for participating in, and the recording of, the interview.

Confidentiality

All data collected was anonymized and participant files coded with pseudonyms and numbers for analysis; I am the only person with access to any identifying information. Every effort was made to ensure that any identifying details in the narrative accounts and study findings were removed. This required that some details of the participant demographics and details be omitted as many participants are the only individual with a particular role or job title within their team, department, or institution. Where any connection could be made to an individual based on a descriptive factor, these details were omitted. All measures were taken to securely collect and store access to identifying information for the duration of the study.

Summary

The case study outlined was designed to use multiple sources of data to inform the qualitative exploration of health professionals' experience in the design, planning, or implementation of a project that incorporated advanced technologies into practice. The interviews, documents, and field notes were analyzed using Saldana's (2015) approach. Care was taken to document with transparency and provide an audit trail to allow readers to determine the

aspects of the study that may provide insight and relevance to their own context. Limitations related to interviewing skills, nature of interviews themselves, and the COVID-19 pandemic, as well as the resulting delays and amendments to the study design, have been acknowledged.

Chapter Four: Analysis

In this chapter, I share the findings from data collected from 16 participant interviews, field notes, and documents relevant to the case study. First, I present a brief overview of participants to provide insight on the roles, expertise, and nature of their involvement with the registry project. Second, I share a brief document inventory that outlines all documents reviewed as part of the data collection. Third, I present the findings from the participant interviews with relevant insight from the document review according to the following four themes: people, environment, innovation, and learning.

Participant Descriptions

A list of potential participants, including study team members, direct collaborators, advisors, clinicians, consultants, and users was compiled by the cardiac registry project coordinator in December 2021, identifying 30 potential participants. Details regarding positions, rank, and titles are withheld due to the unique nature of many positions held by participants (e.g., positions where there is only one such job title in a team or organization). Participants are described by the nature of their relationship to the case study and their professional role. Role in the registry project denotes the relationship of the individual to the case study, with position types indicating the professional role held for employment. Variation in amount of time participants were involved with the registry project is also included to further contextualize their involvement and knowledge of the overall project; this participant overview is presented in Table 3.

Table 3*Participant Overview*

Participant	Pseudonym	Role in Project	Professional Role
1	Morgan	Approver/advisor	Management
2	Riley	Advisor/consultant	Director/executive
3	Alex	Collaborator, end user	Clinician/researcher
4	Drew	Technology partner	Director/executive
5	Nat	Team member, end user	Clinician/researcher
6	Sam	Collaborator	Clinician/researcher
7	Dominik	Collaborator, data use	Staff role
8	Rene	Approver	Director/executive
9	Quinn	Collaborator, data use	Staff role
10	Gabe	Team member	Staff role
11	Parker	Collaborator, data use	Staff role
12	Blake	Team member	Staff role
13	Kris	Advisor	Director/executive
14	Cameron	End user	Clinician/researcher
15	Taylor	*N/A	Director/executive
16	Ali	Team member	Director/executive

Of the 16 participants, six are in director or executive roles, five in staff roles, four in clinician/researcher roles, and one in a mid-level management role. All participants hold at least an undergraduate degree in their specialty; five hold a medical doctor degree, with numerous participants also having an additional graduate degree at the master's or doctoral level.

Document Inventory

The documents collected for review included three that were available publicly (online) and five provided by case study project team members. Table 4 contains the inventory of all documents and sources used in this study.

Table 4*Document Inventory*

Document	Document Description	Source	Date accessed / provided
1	Project Study Protocol	Team member	January 2021
2	Project Consent Form	Team member	January 2021
3	Project ethics application	Team member	January 2021
4	Data disclosure agreement	Team member	January 2021
5	Research program expansion plan	Team member	June 2022
6	Research program overview	Public website	February 2022
7	Health system innovation pathway	Public website	May 2022
8	Health system strategy for research and innovation	Public website	May 2022

Note. Document titles are not provided as a measure of confidentiality as this information may affect the ability to identify study participants.

For the documents provided by the study team member, the project study protocol and the research program expansion plan were most relevant to the themes that emerged from the participant data. While helpful for context, the consent form, ethics application, and data disclosure agreement provided little additional data as the information was more procedural in nature; in particular, the patient consent form provided was the short version and did not demonstrate the depth of consent discussed by participants, though the long version was requested for comparison and further analysis. Two other documents were particularly useful, those authored by health system representatives and made publicly available on the organization's website. The innovation pathway and strategy for research and innovation documents provided tremendous contextual knowledge of the supports, policies, rationale, and

tools available for innovative projects within the health system. While only select items have been included, as they align with participant statements, both the project and health system documents contributed to a contextual understanding and a comprehensive perspective on the journey undertaken by the project team to move innovation from idea to implementation across two complex institutions.

Analysis

Drawing on the interview and document analysis, the following four major themes emerged from the findings: (a) people, (b) environment, (c) innovation, and (d) learning. Participants spoke about the people involved in the cardiac registry project, such as the champion, team, collaborators, and stakeholders who played a role in the design and implementation of the project. Many participants felt that the people involved were the key ingredient in a successful innovation project. The environment in which an innovation project takes place was also explored, with many participants discussing key elements of the culture, politics, and infrastructure that can support or affect ambitious cross-institutional endeavors. Innovation was recognized by participants as being related to the project design, technology, and impetus for change; individual perceptions of innovation were often framed by that person's experience or the context of their role in the project. Finally, participants shared the learning that took place, in relation to both the learning associated with implementation of the innovation as well as the learning that came from the experience with the project implementation itself. In the following sections, each theme and subtheme is presented.

People

A strong re-occurring theme that emerged throughout the participant interview data was the importance of people involved in the project. Key elements of this theme involved the roles, individuals, characteristics, and realities of the people involved in a large, complex, multi-institutional project. Participant insights were organized into the following sub-themes: (a) champions, (b) project team, (c) stakeholders, and (d) collaborators.

The Champion

One of the people consistently mentioned was the project's principal investigator (PI) who was often referred to as *the* champion. Nine of the participants spoke of the pivotal role the champion played in this project. The following three qualities of "the champion" were identified from the data: vision, drive, and skills and knowledge. Some participants also recognized the importance of *other* champions; those reflections are presented at the end of this section.

Vision. Vision was a critical element when participants talked about the importance of having a champion. Five people shared this perspective, describing the clarity the champion presented. They made such comments as, the PI "knew what he wanted" and "had in his mind what he wanted to do." Gabe, Drew, Alex, and Kris all used the word "vision" in their description. Gabe commented that the PI had "a very specific vision" and Drew stated that this was someone "with a vision." Kris talked about a champion as generally being "somebody with a vision who sees the potential in something." Kris also explained vision as starting with the idea and then acting on it, saying that the PI "really had a good idea and a vision for what he was going to do."

In addition to a somewhat pragmatic take on vision was the concept of coming up with an idea and acting on it. Drew and Kris described an element of vision as having purpose by

creating “something that accomplishes something.” Kris described the champion as not only having vision, but also “believe[ing] that what they’re doing will make a difference and they want to make a difference.” Ali’s perspective aligned with this, describing vision as belief in what is possible, that vision comes from an assumption that things can be improved and “why not change the way it’s being done” because “it’s always possible.” The vision of the champion exemplified belief in the possible and an understanding of what needed to be done to make the idea a reality.

Drive. Drive was another crucial characteristic of the project champion. Seven participants spoke of drive by noting such items as being focused, persistent, passionate, and determined. According to Drew, the PI was “a very driven individual” who “works tirelessly to succeed.” Throughout the project, Drew said the PI was “very directed and focused.” Drive was also noted as a quality of success given the complexity of the context of the project. For example, Riley described the drive of the PI as a necessary quality for success in the context of the complex environment in which the project took place, stating that “the system kind of wears you down unless you’re super persistent, passionate.” The complexity of the local system was also recognized by Kris, who reflected that “every successful project has a passionate leader” and that the PI for this work was someone who was “just going to keep pushing at it.” Furthermore, Ali explained that navigating the system is difficult, that “it’s doable, but it’s really hard” and that the difference with this PI was in “not [being] afraid to go down that path.” The success of the project, as noted by Blake and Gabe, can be attributed to the PI’s “determination,” “willingness to push it through” when barriers arose, and “endless energy” to pursue the vision.

Skills and Knowledge. The skills and knowledge of the PI were pivotal to the success of the project. Such skills, as noted by Ali, involved a “triad of skill sets” that allowed the champion

to “navigate this properly” and that domain expertise in critical areas of clinical knowledge, data science, and leadership allowed them to “speak to each one of the people that are partners” in a way that was meaningful to their role and expertise. Others identified the champion’s unique combination of skills and knowledge in both the technology and the research. As noted by Kris, the PI needs to have the ability to engage partners, highlighting the importance of having “a certain kind of personality where you can engage with people” as critical to gaining buy-in. According to these participants, the skills and knowledge of the PI were fundamental to the project’s success.

Other Champions. Three participants referred to champions who were not the PI. They spoke of champions who were supportive at a high level, as well as from various levels within the health and academic organizations. Gabe identified individuals who were “champions on the [health system] analytics side who got the big picture.” Drew reflected on a high-level connection that was pivotal in opening doors to other executive decision-makers and stated that this champion “was the reason we got to have a meeting” to propose the project at the executive level. It is also important to have individuals throughout the organizations who are champions for this kind of project who, as Parker explained, “come from all levels, from higher up in the decision makers to those...who actually get the work done.”

Not all participants mentioned champions during their interview. A common thread across participants who did not mention champions was the role and involvement type; it could be considered that those who were brought into the project to perform a particular task, or whose job it was to review or approve a part of the process, may have been situated differently to the work. Being involved as part of one’s daily tasks may offer less exposure to the types of champion roles and characteristics that may have been more evident in other parts of the timeline

or project development. The PI and other invested champions clearly made an impact on the participants and demonstrated the vision, drive, skills, and connections to contribute to the overall project success.

Project Team

Four participants specifically acknowledged the contributions of the project team in the success of the cardiac registry project. Participants discussed the project team in relation to the following categories: contributions, attributes, and dynamic of the project team. Nat noted one of the team roles as “an essential part of success” and that the smooth functioning of the project “relies on that person.” Some comments alluded to a generalized sentiment about the broader team of contributors, indicating “there’s a lot of supportive people and a lot of people” that have contributed, including “technologists, research nurses, research coordinators” and “all of those are integral” to the project’s success.

Attributes of the project team that emerged from the participant interviews included accuracy, attention to detail, competence, and open-mindedness. Cameron showed enthusiasm about the experience with the project team, describing the team as “fantastic” and “awesome.” When asked what about the team stands out, Cameron indicated that anytime they reached out for information or clarification the team “was always approachable and helpful.” Participants felt that for the project to be successful “you need the problem solvers” on your team, particularly those “who buy into the vision” and work to “try to realize the vision.”

The dynamic of the team was felt to be an advantage to the project, with Gabe crediting the team dynamic as part of the success of the work. Kris felt the role of the PI, or the champion, was also critical here, that leadership that respects their team and their contributions helps to avoid burnout among team members. Team continuity was also an important factor: having team

members who began working “at the design stage from the very beginning” brings consistency and holistic knowledge of the project to day-to-day tasks as the work evolves. Unsurprisingly, the project documents mention little about the direct team of support staff; protocols and research documentation often briefly identify those involved on a project but focus on the science, objectives, rationale, and methods, rather than the individuals that make up the team dynamic. The cardiac registry project protocol does emphasize the team support the program provides to investigators as an incentive for participation; it seems this incentive has proved fruitful for investigators like Cameron and demonstrates the level of importance placed on the team dynamic and the support they provide.

Stakeholders

Stakeholders play an essential role in a complex project. Eleven participants spoke about the many aspects of stakeholder involvement, which were categorized as the following: identifying stakeholders, engaging stakeholders, stakeholder motivations, and challenges. The interview data illustrated perspectives on who the stakeholders are and how to communicate, engage, and generate benefit for stakeholders, and explores the values and motivations of stakeholders to engage in such projects. Finally, participants shared some of the common challenges related to timing, workloads, and threats to stakeholder buy-in.

Identifying Stakeholders. According to five participants, defining the *who* of a complex project comes down to identifying the stakeholders, understanding roles and relevance, and considering the level of stakeholder involvement relevant to the work and feasible for the individual. Participants discussed the difficulties in identifying who should be engaged. Morgan felt that “it’s really hard sometimes to understand who the relevant stakeholders are until you get in the middle of [it].” Morgan continued to describe the critical nature of identifying the right

people and the potential consequences of missing key stakeholders, that “you’re going to get this far and then these guys are going to jump in and go ‘hold on, how come we weren’t engaged, how come we weren’t part of the decision’.” The balance of stakeholder involvement is also important. From Drew’s perspective, identifying stakeholders should be a targeted endeavour. He emphasized that “we don’t need to target everyone” and that identifying those who can bring value to the work as initial stakeholders may be more helpful.

While many participants spoke broadly about finding the right stakeholders, Drew pointed out that sometimes it is “not just the people you want but also identifying the people you do not want,” explaining how a negative stakeholder can strongly impact others and suggesting that specifically “identifying the people with vested interests that align” is the best way forward. In contrast, Alex felt that a broad approach to stakeholder identification was best, suggesting that one might begin by inviting “everyone to the table who you think would want to be there” and that from there “people kind of select themselves out.” By doing this, one can show a broad and inclusive approach to stakeholder identification, yet those with the time, energy, and interest will remain involved.

Identifying stakeholders at all levels of an organization was addressed by Sam. Sam highlighted the multi-disciplinary stakeholders involved in the cardiac registry project beyond the core team and collaborators, highlighting the additional roles of “staff and technologists and the booking clerks” as integral to overall buy-in. Knowing who to include and when is a key factor: as Ali noted, understanding “how to navigate to the right person at the right time” in an attempt to gain buy-in when it is most relevant for that individual or role can be beneficial. Other participants echoed this perspective, finding that knowing when to approach individuals with different roles and levels of decision-making was important. Additionally, participants talked

about “knowing the scope,” “identifying decision-makers,” and trying to determine who “would have that [right] lens” to inform on the project at various points in the timeline. Participants found that having multiple stakeholders engaged was reassuring so that responsibility and decision-making was at the institutional level and not on any one individual.

Engaging Stakeholders. Participants shared insights on how to engage stakeholders including engagement strategies, communication, and providing benefit. Engagement strategy discussions ranged from starting with a bottom-up approach by engaging “the people on the ground” first before taking it up the ladder for approvals to potentially being “a little bit top-heavy” as more leadership roles becomes engaged. In the beginning stages, Sam emphasized the importance of “get[ting] people engaged and excited about the project,” with agreement from Morgan, who felt that “looping in the right people from the beginning is crucial.” Participants talked about the effectiveness of holding meetings that all stakeholders “were invited to and included in” as a mechanism for providing input and being involved in an “open forum and a kind of knowledge exchange.”

As initial engagement efforts were made, participants drew their thoughts to what is done to gain buy-in or endorsement for the project. Numerous methods of gaining support were mentioned, including drawing from previous successful projects as a means of “reassuring them” of the experience of the PI and the team. Simple explanations were also found to be important, such as sharing insight not only on “how [we’re] going to do it” but emphasizing “they really needed to understand why.” To do this effectively, Sam felt strongly about trying “to personalize the discussions” and help them see that “it’s going to be useful,” while most importantly “show[ing] the big picture of things too.” Knowing your audience was prioritized by three participants. For example, Morgan shared in-depth examples of the critical nature of “talking at

the right level” but cautioned that it “will really vary from individual to individual.” When engaging stakeholders, there is “no recipe to follow”; flexibility is required to constantly adapt to the needs of the individual stakeholders involved.

Communicating with stakeholders is an important element in engaging stakeholders and acquiring support for the project. Communication was described as a range of approaches from informal “awareness” and “elevator pitches” to formal presentations and written documents. In sharing critical information with potential or new stakeholders, Morgan felt it was essential that project teams communicated the “impact to your team” in “a digestible manner” and that these communications ought to be tailored “based on your audience.” Riley similarly felt that communications should be presented early in the process and in a “consumable enough way that you can pass it along easily.” Succinct and informative communication was clearly prioritized by these participants.

Communication was critical in representing the purpose of the project as many participants felt that some stakeholders, described by Gabe as less supportive, “maybe didn’t understand the vision at the beginning or kind of get it right away.” While understanding the project fully may not be required to be supportive, some felt that stakeholders became “just neutral” or that the project “wasn’t prioritized” by those who were perceived to have a lesser understanding. Conversely, others were described as those who “got the vision” and subsequently “were really supportive.”

The final aspect of how participants described the mechanisms of engaging stakeholders was to offer and demonstrate benefit. Kris felt that successful engagement strategies “show how it can benefit everybody,” a sentiment Ali echoed by stating clearly that “everybody’s got to win” and that creating value from the project that will benefit stakeholders is key to gaining their

endorsement. Alternately, Gabe felt that perhaps not everyone has a win in every project, that those with a vested interest in the project outcomes, in this case a research output, “would have been more excited about it... and jumping on board.” Other participants shared similar perspectives, that stakeholders who saw benefit from the project in relation to their own work “were much more involved and engaged” and with a lot of people to engage, “it’s hard to really make sure everyone’s appeased” but that it’s important that “everybody’s needs were appreciated and understood.” Drew stressed the need to demonstrate value to the key stakeholders in the relevant institutions in order to make progress through the various business pathways.

The health system strategy document for research and innovation emphasized the need to identify and engage stakeholders at all levels and with varying perspectives throughout the phases of an innovation project. In particular, patient partners and frontline clinicians were highlighted as those with the direct expertise and contextual knowledge to bring a critically relevant lens to intended solutions. The cardiac registry study protocol outlined the secondary aims of the study that included stakeholder engagement at the patient, physician, population, and institutional levels.

Stakeholder Motivations. Seven participants shared insights about stakeholders and what it is that motivates them to buy in or contribute to this kind of complex project. Parker shared their own motivations, explaining a general interest in “technology and adapting things” while also noting their sense of contribution “to the field of research” by helping “to make that possible.” Numerous participants felt that this kind of project work is “where the excitement happens,” particularly when it comes to “new technologies and new ways of doing things” which many felt was “a passion of theirs” and something they “really see value in.” Riley described their own motivation from an altruistic lens, sharing that they were happy to lend their support to

a project if they “genuinely feel [they] are doing what’s right for [patients].” In a similar way, Kris felt that the intention of the PI and project purpose can be motivating for stakeholders and that they like contributing to “projects like this” when there is “a genuine desire to improve care...because you know that their intentions are good.”

Kris shared further perspectives on the motivations of stakeholders, stating that as an advisor, you are “only useful if they respect what you say”, which affects not only how effective an advisor can be but also how motivated they are to contribute. Other participants shared similar thoughts, emphasizing the importance of “get[ting] people’s input on it and really try[ing] to use some of it.” Other reflections included giving stakeholders the opportunity to take responsibility for small aspects of the project, that providing a “sense of ownership and autonomy” can improve engagement for those who are driven to be more than an “advisor or sounding board.” Ultimately, stakeholders often appreciated “recognition related to what they contribute.” Demonstrating the value of stakeholders’ time and expertise was deemed important to successful ongoing engagement and can ensure that important input is provided.

The health system strategy document for research and innovation outlined that frontline care providers who manage the day-to-day care of patients want “earlier and greater involvement” with research projects and innovative endeavours, including new and emerging health technologies. Similarly, the strategy document to expand the cardiac registry project lists numerous clinicians and investigators as research collaborators in key clinical, research, and data science specialties. This type of multi-disciplinary project with stakeholders from various backgrounds demonstrates that innovation project designs are taking these recommendations and embedding them in the work. The registry project protocol outlined the importance of engagement pathways as contributing to the success of dissemination into the clinical

environment. While there were no specific details provided as to how this would be accomplished, the prioritization of engagement as part of the technology transfer process was part of the recommended infrastructure.

Challenges. The challenges participants shared about engaging stakeholders focused on difficulties in timing, resistant behaviours, and busy workloads. Sam felt that engaging people early on may help in avoiding a “sense of later resentment” while Morgan stressed the difficulty of “getting in front of all the right people at the right time.”

Numerous participants spoke of stakeholders they felt were resistant to supporting the project or buying into the vision. Ali and Kris talked in-depth about their perception of resisters, relating it primarily to those that “may be threatened by change” or affected by something that the project “is going to interfere with.” This is often compounded when those stakeholders “don’t understand what you’re doing.” In addition, there is the added complication of a threat to others’ success when “people are competing for resources” that may include grant funding, attention, or even the perception of favour, such as “the Dean’s attention or accolades.”

Ali felt that realistically there are “going to be a large number of people that just have very little interest” and that lack of interest may be perceived negatively by those attempting the change. Ali suggested that someone “uninterested” may be falsely perceived as “resistant or undermining” and that project teams should resist the reaction to feel “angry or frustrated” when this happens. Project teams may need to accept that there is a “continuum with different levels of engagement” and “that is okay.” Participants spoke of resisters as perhaps “not buying into the larger vision” or not “interested in the reason behind the work.”

Gabe felt there were some lingering sentiments of wanting “to do it the way they’d always done it” despite the change being designed in such a way that “it’s not any extra work,

it's just different work." Similarly, Sam felt that resistors are sometimes put off by the expectation to take on "the same manner of reporting" as every clinician in the centre, suggesting that standardizing the work reduces their own autonomy in their practice. In the document review, the project was explained in relation to the resulting innovations that were designed to be complementary, not disruptive, to the hospital information system and the clinical workflow.

Finally, busy workloads were commonly mentioned as real and potential challenges. Alex described the project stakeholders as "very, very busy people," explaining that it's "a very delicate balance" to attempt to engage stakeholders knowing that it may involve "adding work to their plate when they're already busy." Some participants felt that "everybody's burnt out" already and relying on the value or benefit a proposed project will bring helps to "remind everybody why we're doing what we're doing." Ali suggested to approach busy stakeholders with "the solution rather than the problem" and that understanding the workload and pressures helps to frame stakeholder relationships. One participant shared the difficulties of the current environment, stating they felt "almost beaten to submission" in some areas of their work. A project team needs to take time to assess the current context in the work environment and organizational pressure in an attempt to strategize engagement approaches to reflect the nature of current circumstances.

Collaborators

Distinct from stakeholders, who often help to inform a project or are involved in or affected by a decision, collaborators are those who have a specific task related to the project. Participants explained the roles of collaborators in this context as those whose job may have involved tasks that helped move the project towards completion or success. Commonly, this was discussed in reference to data analysts, as these collaborators are often in a position to be tasked

with the transactional responsibility of retrieving, organizing, and exporting data for this type of project. However, in a research context, collaborators are also individuals thought to have contributed to the design or implementation of a project where they share skills or expertise to move the work forward. Five participants spoke about the collaborators involved with the registry project with emphasis on skills, iterative processes, and motivations involved in contributing to the project.

Three participants spoke of the general skill needed to contribute to the project, emphasizing the importance of “having an analyst who knows what [they’re] doing,” even describing the analyst role as “absolutely critical in many cases.” Dominik framed the role of the collaborator in relation to the bigger picture of the overall project, explaining that “having a good analyst is really going to help you do a good job, but if all you’ve got is a really good analyst, that’s not going to be enough.” Participants also identified the level of data knowledge of the researcher or project team as an important factor for the collaborator, acknowledging that while the researcher has “a lot of clinical experience,” on the data side “probably they [the analyst] will have more knowledge”; together this can prove an advantageous partnership.

The iterative process was highlighted as the primary function of the relationship between the collaborator and the PI or project team. Blake described this process as problem solving, such as “all of us working together” to find a process or understand an output. Other participants felt the purpose of the iterative process was refinement, as Parker reflected about matching institutional data with the needs of a project that often requires that “you go back a few times until we kind of refine things.” Often clarification is the purpose, described as a sort of “negotiation between the analysts and the researcher” which involves “working directly... to get exactly what the requirements are.” This iterative process is crucial according to Quinn, who felt

that being able to “talk to a researcher to clarify some points” often resulted in a moment of certainty where both parties realized that while the initial request may have asked for one thing, “what you really need is *that*” — something else. These realizations could not be arrived at through any other process than the collaborative and iterative activities that are especially meaningful when everyone brings “specific but complementary knowledge” to the table.

Finally, participants alluded to the motivation of collaborators as contributors in the project space. Participants felt that a collaborator’s motivation to contribute was an advantage to a project, while others felt that the energy and excitement of the project team helped to motivate the collaborator. While in this definition of collaborators the tasks assigned were delegated through the responsibilities associated with their employee roles, the impetus to perform at a high level is often elevated when “you’re working with people who... have some enthusiasm for what it is they’re doing.” Parker summarized their perspective by stating, “creating new tools or capabilities and being involved in research projects is what piques interest for a lot of people” and that desire to participate and contribute motivates collaborators “to mak[e] sure these things are successful.”

The research program expansion plan document indicated the need for expanding capacity for investigators to access high quality data and achieve success in various research activities, such as grant competitions and publications. Similarly, one of the health system documents acknowledged that the potential for users to access health information to generate evidence and aid in decision-making “remains to be fully realized.” The challenging balance lies in protecting patient records and sensitive data while attempting to improve care via information sharing with appropriate security protocols to make “the right data available to the right people at

the right time... and use it in meaningful ways to improve the delivery of healthcare for [patients].”

People: Synopsis

Overall, the people involved in the project were described as representing a spectrum of input, skills, and motivations with their contributions aligned with the nature of their role to the project (e.g., as a champion, team member, stakeholder, or collaborator). Participants reflected on pragmatic aspects of engagement, communication, skills, and knowledge while also exploring the concepts of motivation and value. As the participants in this study ultimately belong to one of the groups of people above, it can be argued that perspectives on the people theme may be significantly related to the way in which these participants themselves were included, engaged, and empowered and the context and conditions under which they contributed their time, expertise, or knowledge.

Environment

The ways in which organizations conduct business, and the subsequent ways that employees function within these systems, can have a major impact on the work that is done. Similarly, external factors that affect these systems also play an important role. Participants shared insight into the environment that surrounded the cardiac registry project, demonstrated below with participant data that have been organized into the following five sub-themes: (a) infrastructure, (b) resources, (c) culture, (d) politics, and (e) external elements.

Infrastructure

The infrastructure of an organization, such as the facilities, services, processes, and structural organization of the way business is conducted, is the underlying base or foundation of the institution. Eleven participants provided insights into the infrastructure relevant to the cardiac

registry project, which have been compiled into the following categories: policies and processes, siloes, and system barriers.

Policies and processes. Policies and processes, also described as regulations, guidelines, or approvals, were identified by seven participants as a key aspect of the institutional environment. Policies and processes were thought by Morgan to bring alignment and helped everyone to “play fair” by keeping “everybody under the same expectations” in a “purposefully kind of structured way.” It was felt that these elements “exist for a really good reason” and play an important role in a large organization “to harmonize what we’re doing.”

Rene and Kris spoke about the responsibilities of those in positions of approving or reviewing projects that flow through these institutional systems and the accountability of “ensuring compliance with critical policies and legislation,” including “legal issues around the Health Information Act” and requirements of the Research Ethics Board. Beyond the checks and balances, there were also supports to “try to navigate [projects] to the right place” to ensure things keep moving forward. Where the size of these institutions can be a challenge, Kris weighed the benefits of having “a whole army of people that want to help,” who also know that they are responsible to “follow regulations and requirements,” with the data analysts as those “who are ultimately responsible for the release of data.” While projects tend to progress through the system at various paces, Parker found that many in the system work to “balance the different needs of different researchers to kind of keep the wheels churning” and that balancing projects in parallel allowed staff to move one forward while another may be held up in other administrative queues, such as those for approvals and reviews.

While some participants experienced frustration when they did not find “the process very well laid out or clear,” it was believed that “those processes were evolving at the time” and that

they are “still evolving.” Gabe felt that this evolution of process may have also been the result of improved communication across siloes, noting that now “ethics talks with med legal, who talks with [health system] research offices” and that these improvements are likely the result of “having more experience” with new types of projects. In addition to growth through experience on the institutional side, Parker acknowledged that while “there’s a lot of hoops to jump through,” project teams and researchers also have a responsibility “to be properly prepared” in order to “make that process smoother.” The continued evolution for individuals, teams, and institutions is potentially a step towards becoming “a continuously learning health system environment” and what is happening in this growth phase is “building an infrastructure to support that.”

Siloes. The use of the word siloes is common in the healthcare environment when describing teams or institutions that often function in isolation of one another, or those that seem not to be well connected. Siloes were identified by five participants as a particular challenge in navigating innovative projects through large institutional systems. Riley described the siloed landscape as “clunky” and felt a disconnect between steps in the process is a risk for “not translating the passion and the vision” as the handoff occurs to new teams brought on during the lifetime of the project. Rene noted that the institutions themselves were “not very good at connecting all the dots and making sure that we are still aligned” and that “projects with this complexity” can exacerbate or highlight these issues. Siloes were described by Alex as “very common” in academic and healthcare environments, with other participants agreeing that it can be as simple as not knowing “what the person who works beside you is doing” or when “those in the surrounding space don’t know what you do.”

Ali, Kris, and Gabe suspected that a potential cause or symptom of siloes is that “there isn’t a lot of communication or clear communication,” which adds to the challenge of navigating these systems. From Kris’ perspective, “to avoid siloing you have to have good leadership” across the institutional spaces to keep people engaged without feeling like it’s “just another job you’ve given me.” Participants expressed frustration when acknowledging the siloes, considering that these connections “ought to be easier than they are,” but admitted that this issue is common in healthcare, academia, and large organizations in general. It was, however, felt that the negative impact of siloes is compounded by system barriers that are presented in the following section.

System Barriers. Six participants spoke of slow or complicated pathways in both the academic and clinical institutions, particularly when processes transition from one institution to another. A number of participants spoke of potential or actual “sticking points” in the junction “between research and clinical” spaces because the “resources aren’t in place to make it work” and “it’s not an easy road.”

Cameron admitted to feeling overwhelmed with the “administrative hula hoops” of the system, while Kris and Riley both felt that despite efforts to the contrary, the health system is often “not innovation friendly.” Riley expressed frustration at some of the attempts to streamline the system, explaining that “we just seem to go back to reinvent or solve the same problem over and over again” and despite best efforts there is no “well designed, effective conveyor belt to push innovation through the system.” Sometimes these challenges can trigger creative solutions, such as those Kris described that have found a way to have a team member “embedded in the system” and while that can create efficiencies, those individuals are ultimately institutional employees and held to the same policies and procedures.

It was reported in the interviews that system barriers sometimes dishearten participants from within and external to those institutions. Some participants spoke of the “confusion” that ensued and the effort to “figure out what needs to happen in what order,” while others admitted that the weight of a convoluted system can sometimes get “to a point where I’m wasting people’s time.” Riley shared feeling “embarrassed sometimes to try to shepherd something through” and feeling torn when there is “a great idea” yet they “don’t see being able to get this through.”

A common challenge is the time it seems to take to move innovation or complex projects through the system. The process has been described as a “cycle that is just way too long” and exists in “a massive organization” that Parker admitted is “still slow... it’s not like a fast-moving start-up where decisions can be made very quickly.” However, Rene explained that this is all a process, that the system is “getting more sophisticated, and every case like this... it’s a learning opportunity” for those in that space. It was clear from the participant experiences that the process has improved, perhaps in part due to projects like the cardiac registry that have paved the way and brought awareness to the infrastructure needed to pursue this type of work.

Resources

The resources participants talked about in reference to the project were defined broadly as something that one uses to achieve an objective. In eight participant interviews, resources were referred to primarily in terms of elements that make up the following categories: personnel, technical resources, and competing priorities.

Personnel. The most common comments about personnel as an institutional resource centered on people’s time, alluding to staff as “just busy and short on time,” “spread so thin,” and that “if there’s any disconnect, to be honest, it’s time.” Morgan felt that in order “to do everything this organization really values” they would need more people to make that a reality.

Often once a request was submitted, Gabe experienced a lot of waiting “because you had to kind of wait for a place in line.” Some felt that the organizations often have roles filled by individuals who may not have the specific experience related to these kinds of project requests. For instance, it was felt by a few participants that there are often “non-technical people in technical roles” and that this may have introduced additional complications when individuals “make key decisions when they may not understand... to a high enough level” the nuances of technical or innovative data projects.

Technical Resources. Parker shared insight into the common challenges encountered for projects that are affected by limitations of technical resources. For instance, there were times when “the research server actually ran out of storage space” which triggered a time delay while the researcher or project team worked to procure additional resources; this was often a place where a bottleneck occurred. Other technical resource issues involved data systems that were linked to the clinical space. As those systems “are actually used during the day-to-day operations,” Dominik explained that project work must take “a back seat” to ensure there is no “negative effect on the network, on the server, on real patient care.”

Competing Priorities. When resources were an issue, participants felt that juggling priorities became part of the challenge; projects that fail are perhaps just those that “weren’t prioritized.” In Quinn’s experience, there were “a lot of projects” waiting to start but “not everything can be supported... sometimes higher priority trumps the other one [project].” Riley found competing priorities to be quite a significant challenge, questioning if as “an organization... [there are] just too many priorities.” In instances where this became difficult, it was often the individual tasked with the work who faced the struggle, particularly if leadership “change[d] priorities halfway through, because there’s a new priority.” Morgan felt conflicted at

times that the organization was seen as “somebody saying ‘no’” when in reality it’s often something that “should move forward, but it’s priority 755 on the list.”

The participant insight on resources was relatively straightforward; participants felt the issues were both pragmatic and static, that any potential for increased or improved resource availability and allocation was simply not a reality. However, the contributing factors to resource considerations were similarly tied to the other aspects of environment noted in this section and in particular can be subject to sudden changes in contrast to other environmental factors, such as culture, that often develop and become embedded in an environment over longer periods of time.

Culture

It was reported that the culture of an institution can often be gauged by the formalized values, vision statement, or communiques about the organizational priorities and manner of conducting business. In participant interviews, the culture of an institution was spoken of as the way in which employees go about their work and the common ways of functioning in that space. Six participants spoke of the culture and values of the organizations. Parker described the core values of the organization as the “pillars executives have selected to influence the institutional direction” but explained that “everyone instills it to a different level” in their work.

Core values are not always easy or clear to instill. Quinn shared that sometimes one value must take precedent, noting that “sometimes we prioritize the organization, sometimes leadership, sometimes patient care,” and that there is no “particular one thing to determine that [priority]” at a given time. Riley also addressed this sometimes-fluctuating sense of the institutional values and questioned if “we really understood” what the primary objective was “we would sort things out a little better and be a little bit more practical.” It was considered if perhaps the institutions were trying to prioritize too many things and that trying to be both “a health

service delivery organization” and “a research organization” might have created a space where individuals asked “what’s our real purpose” when they should be asking “is this really good for [patients]?”

The cultural dynamic of the institutions was described by Morgan as “anyone I’ve dealt with” is making decisions not based on power dynamics or personal interest but based on “what is right for the organization.” Parker echoed the sentiment that “as a whole... everyone wants to reflect a positive culture.” Kris and Rene both spoke about trust across the academic and health service organizations. In Rene’s experience, “there’s a lot of distrust between our organizations” which has become “a culture.” Kris described it as a “tension” where “each side is trying to protect their priorities but sometimes clash” in a way that is cumbersome and can negatively impact productivity or momentum on certain types of work. While Rene maintained that the healthcare institution is “trying to facilitate research” it was often felt that the academic partners “think[s] we are trying to put up red tape” to a point where “every question we ask” was perceived to be “answer[ed] with disdain.” This cultural divide of distrust was felt to be changing and participants have noted that “the culture has shifted” after significant efforts focused on “establishing that trust and creating transparency” across organizations in order to “figure out how we can work together.”

Political Elements

There are political elements to consider in any complex scenario, particularly those that cross heavily governed or regulated industries. Nine participants described aspects of the project that were noted to stem from or have a political element, predominantly falling into categories of power and barriers.

Power. Power, noted as belonging to individuals with the ability to make high-level decisions, was perceived as an important, even critical, element by four participants. Power was felt to have been organically acquired by a project if there were “leaders in a space saying this is really important” and if it addressed both “strategic priorities within [the health system]” and was also “aligned with academic priorities at the university”; that kind of “power behind these projects can make a lot of things happen.”

Power was described by Drew as a project that has “more big guns behind it,” referring to individuals in power, and that this high-level support provided a level of protection for a project to “deal with all the various political things.” While Drew felt that support from those in power was protective of the project, Rene suggested that it also provided a measure of protection for others involved in the project pathway in that “there’s more political will to make it happen” and the leadership was often seen as “willing to absorb the risks” which can lessen the risk taken on by other stakeholders. Sam and Drew both remarked on the importance of knowing who holds certain power within an organization, such as “who owns this, who’s managing this... how much is it supported by the University or [the health system] and who is willing to pay for this?” This is also important in decision-making when you “have to know who is going to be the person actually saying the ‘yea’ or ‘nay’.” Essentially, you need to have your “finger on the pulse of the politics” because “that can make or break anything.”

It was discussed that when legitimate positions of power were levied, they added weight to the support of a project. Parker felt that having “the right person, that is, the right champion to push” will help move a project forward. The power advantage was explained by Ali as “if [the PI] had not been in a leadership position... I think that [they] wouldn’t have been given the courtesy that was given” to push forward. Other participants described this as “political latitude”

which can allow someone “to do something which very few people have done.” Power can also be leveraged in seemingly questionable ways. Kris recalled “an ineffectual strategy” in a similar project where an individual in power attempted to push something through, however the issue at the time was related to legislation. Kris explained that regardless of what level of power an individual has, “you can’t change the legislation by calling somebody.”

Barriers. Barriers exist within the administrative and political spaces within organizations. The political elements were declared by Riley to be “actually what kills a lot of this stuff.” Political barriers were described as issues with ownership and territory “at all different levels” and presented one of the “biggest challenges” in project success in these types of institutions. Ali contended that an administrative political barrier can occur when “what you want to do interferes in any way with an agenda that’s already been established.” Ali clarified that this is not about “secret agendas” or anything untoward but can be “a legitimate agenda” which simply may not align with or complement the project someone has proposed.

Political barriers have also been described as part of the “political game.” Drew, who participated in a more technical role, felt that they kept themselves from some of these barriers by claiming “I’m not going to go play the political game” and focused on a mindset that the “only thing that matters is [the] work and that will speak for itself.” However, others felt that perspective can be limiting and that it is “just not how the world works if you want to do anything important.” Dominik felt they had played the political game at times in their career and described it as “the existential crisis caused by politics”, adding that when you see “people rise above the political game” that is usually “because they’ve won the political game.”

The political elements were described as being both reflective of and connected to external elements in a way that may be impacted more strongly than other categories within this

infrastructure section. While internal political elements of power, and the barriers that arose, can be considerable in any context, the effect of factors in the next section of external elements can easily be intertwined.

External Elements

External elements can play a pivotal role in the environment where projects like the cardiac registry take place. Five participants provided insight into the types of external elements that have arisen in the course of the project. Four of the five participants identified the COVID-19 pandemic as a critical aspect of the current environment and one that has impacted many projects over the previous two years. Alex stressed that even the typical challenges and barriers are “compounded by things like pandemics and budget cuts” as part of the “realities that we face.” Quinn and Dominik commented on how “everything stopped” when the pandemic hit and “a bunch of projects died because... people just got conscripted to go do other things.” Personnel being tasked with focusing on pandemic-related priorities became common and participants admitted that it seemed that some projects “sort of fell through the cracks” and that timelines “may have slowed down during COVID” to an extent that would have been “unheard of three or four years ago.”

While COVID-19 was understandably fresh in participants’ minds at the time of the interviews, Riley and Alex also contended that other external factors are often prevalent, such as “budget cuts” and the influence of things “forced on you by outside the system.” Government politics play a role in what happens in institutional spaces, though often the downstream effect is absorbed in a “much more rational kind of way” because “we can’t solve those problems.” Riley described a tension between enacting downstream tasks of government decisions when in their

mind “I work for [the public], that’s how I internalize that.” It was postured that a “depoliticized delivery system” would make us “so much better off as a healthcare system.”

Environment: Synopsis

Participants reported elements of the environment that impacted the work of the cardiac registry project to belong to categories related to infrastructure, resources, culture, politics, and external elements. Ranging from day-to-day aspects of work to broad-scale issues (e.g., priority setting to global pandemics), it was clear that participants had experienced a variety of situations that influenced the progress of a complex initiative. The tenuous nature of some of the environmental elements, particularly those beyond the control of participants or those whose status can change rapidly and unpredictably, can radically change the space in which this type of work takes place.

Innovation

Innovation was a primary focal point of this study and unsurprisingly many participants spoke of various aspects related to the project and the innovative elements associated with it. Eleven participants spoke openly about the elements of innovation that they observed or participated in at different times through the lifecycle of the project. The following are four sub-themes identified in relation to innovation from participant data: (a) perception of innovation, (b) project design, (c) technology, and (d) change.

Perception of Innovation

Six participants spoke of the generalized definitions, attributes, or individual understanding of innovation, which adds context to the perspectives raised throughout this section. Taylor explained their view of innovation as “discovery plus application,” but that discovery does not mean “invention,” it can “also mean just finding it in another health system,

another jurisdiction, or another sector and you want to apply it in the health context.” Similar points were raised by Gabe who felt that some of the aspects of the work done to move the project forward were relatively standard but that even though some of the steps involved were not necessarily innovative “that doesn’t mean that what they’re doing isn’t leading edge.” On the contrary, the progress of the cardiac registry project also fed the need for additional innovations, such as Parker’s initiative to build something new to address a gap in the data workflow process within the institution that would assist in meeting the data needs for projects like this one. Parker identified that they “saw a gap there” which provided “a chance to create something of value.” Drew suggested that their perspective on innovation was rather polarized, explaining “there’s only two options... one is you do what has always been done, or you create [something new].”

Other general perspectives on innovation were those who considered the evolution of ideas and processes as central to innovation itself. Nat believed that innovation is always fluid and that “even if you build the perfect structure” it is only perfect at that moment and if you stop innovating “it’s going to be less successful because things change with time.” Other participants agreed that there is always “a lot more potential there that we can do” and “value that can be found.” Furthermore, with this kind of evolution “you can’t really know things until you know them,” so each step in innovation requires that you continue moving forward. Drew felt this evolution was reflected in institutional structures as well, such as grant competitions that often shape the innovations that are successful by selecting the priorities and projects that receive funding. For instance, aspects of artificial intelligence were “buzz words” for some time, but now “there are a lot of grant competitions that are going ‘yes, yes, machine learning is fine, but that’s been done’” so it pushes innovation to always move forward; “there is no stasis” in an innovative mindset.

The health system innovation document outlined not what an innovative project ought to be, but what it ought to offer the health system: improvement in the quality of care, economic benefit, feasible implementation, and health equity improvement. The document did not provide insight into the kinds of projects considered innovative, though it did distinguish between technological innovation and non-technological innovation. The document instead was focused on the nature of implementation, goals of innovative projects supported by the organization, supports and tools for successful uptake and sustainability, and the importance of evaluation to assess care improvements or cost savings.

Project

The innovative aspects of the cardiac registry project design were described by eight participants. A few notable, overarching aspects of the project design that participants identified as innovative included “the scope of data that’s being collected,” particularly “the patient-reported outcomes,” describing them as “very important” and “very novel.” Ultimately, Alex stated, “I’ve not seen that anywhere else.” The specific aspects of the project considered innovative by participants were organized into the following categories: data integration, standardization, ethics, and evolution of project design.

Data Integration. Participants felt that the integration of the patient-reported data with the data in the clinical information system and linking “all of that in a kind of seamless workflow” was “one of the unique aspects of [the project]” and “was really rather amazing” to have “integration with the administrative health databases.” Sam indicated that the method of choosing the variables that would be collected or integrated was also rather unique, that the PI “engaged [clinicians, researchers] to see what variables [they] would like in the database,” that the dataset selection was a collaborative process that “was new for us” to be involved in.

Standardization. The standardization of data collection and reporting was also new for the purposes of the cardiac registry project. An aspect of standardization that stood out to three participants was addressing the data going into the registry “from the very beginning” by implementing “standard scanning protocols” that are “really unique” for an imaging centre. Nat explained that in most centres the scanning protocol is at “the discretion of the scanning technologist and the attending physician who is there that particular day,” with Sam characterizing that the new process as “programmatically reporting, whereas most radiologists report in free text.” This move from free text and individual clinician reporting practices to a standardized process was thought by Gabe to be “an improvement on the clinical workflow” that also ensured “very high quality data” to populate the registry. The cardiac registry protocol outlined the value of the registry as contingent upon consistent analysis and reporting, with the risk of diluting the data if standardization is not maintained. With this consistent reporting and standardization, the value of the registry and the potential to impact patient care was improved.

Ethics. Another unique feature of the cardiac registry project design, according to participants, was the ethics approval process. A number of unique aspects of the approved ethics application were highlighted by four participants, including Cameron, who explained that additional projects by collaborators could be completed under the initial ethics approval. By doing research that “falls under an established and approved protocol” the process for data was much quicker than “doing it from scratch”; this novel approach was “frankly amazing” and “very different from any other experience” when conducting research. Alex also pointed out this novel design and credited the team in that “there was a lot of work to get there” and that those who approved the ethics application “also deserve credit” for “being opening minded to it and working with the leadership to make it a reality.” Alex thought back to the importance of this

ethics application design and acknowledged the approvers for “seeing that this is something new” and being able to accommodate “something different than what they’re used to seeing.”

A particular aspect of the ethics protocol was the patient consent process that Nat felt was “simply brilliant” because it has “two levels of consent.” In this design, patients have additional choices beyond a typical yes or no, giving broader options for participation and, from Nat’s perspective, “would actually lead to more patients saying ‘yes’” simply because they are offered more choice and “feeling appreciated as a patient” that they might be more open “to being involved in a higher level.”

Evolution of Project Design. The discussion of the project design as an area for innovation generated thoughts on the evolution of research design from four participants. Cameron explained that in a traditional research project, an ethics board will expect to see “a clear question, an objective” and the protocol then details “how you’re going to go about answering that question.” Ali clarified that in the traditional approach, with data, “you need to know what data you’re asking for.” However, in the cardiac registry project, Rene expressed concern that when there is “no one research question it was seeking to answer,” the purpose becomes “a collection of information for an undetermined future research purpose.” The perceived risk of this approach, according to Dominik, is that projects may push the boundaries of data privacy, claiming that those who need to see the data to know what they’re looking for may have a tendency to “just ask for everything.”

When asked how this innovative project design was approved, Ali explained that the patient consent process, as described by participants above, was key. When reaching out to university and health system reviewers, the project team were able to rely on the consent design that allowed the project team “to use the data for this purpose.” While obtaining consent for

every patient in a registry is a more difficult journey than attempting to get a waiver of consent for patient data, the mindset of the team was that “we’re going to do it right.” This shift in the culture from traditional research project design to innovation was considered “a foreign concept” where the foundation is “that we don’t understand the data enough before we actually allow it to tell us what its value is.” In some ways, the team felt they were “not launching a study” but “launching a continuous learning environment.”

Technology

Discussion of technology is bound to arise when exploring a project that incorporates so many technological elements as part of the project function and output. Ten participants spoke about technology during the interviews, with a focus on the technical design, evolution, and impact.

Technical Design. The design of the technology was described by participants as crucial due to the impact on data quality. Nat explained that the “technical aspect” must be “really well thought of from the beginning” to “guarantee the quality of the data.” Sam agreed, insisting that the core function of the technology, “the ability for the actual software to do” what is required was “very key to the project.” Beyond the functionality, Drew felt that the design of the interactions of individuals with technology were critical to the project, characterizing a successful design as “invisible” and one that is “working so well it’s just seamless.” In fact, Drew articulated that the interactions users have with the technology need to be “easy” and grounded in the “real world context that it’s going to be used in,” even arguing that “most clinical AI tools fail in production because you’ve separated out the development from the real world.” Other participants supported the importance of user interactions, such as Riley who claimed that the technology “has to be really intuitive” and Blake who explained that the thought

process for technology design should focus on “what would a user want to see who’s actually using this.” Gabe suggested that it required both the technical tool and then “getting adoption from the community to use it” that is “make or break” for success.

Iterations. When discussing the technical elements, four participants emphasized the evolution of a project like the cardiac registry through technical iterations. For Blake and Cameron, this development was illustrated in the iterative processes that refined the technical elements themselves, such as Blake’s description of going “back and forth” between “trying to build” the technical workflows and getting the team “what they wanted” by “making changes accordingly.” Cameron framed the iterative process as being similar to “a work in progress,” continually identifying issues and gathering feedback to “brainstorm and work on a way to do that together.” Dominik shared insight into the perspectives of different analysts on the iterative process, that some might assume that multiple iterations means “they didn’t know what they were doing” whereas Dominik explained that it’s “because they kept figuring out more and better things to do with it [the data].”

Participants also pointed out that the iterative process is part of the landscape of technology, that the “datasets are always evolving,” tools go through “different variations” and there is inevitably a “latest version of the software.” Parker remarked that technology and innovation also spark other types of evolution, such as an “automated tool” that they developed to meet the needs of “projects like this one” which allowed analysts to “extract the data in an automated, efficient way.” This was echoed by Blake, who explained that as the dataset for the cardiac registry grew, the capability to extract and process data became more efficient, even as they “keep reiterating [the project] based on what [users] want” to add more and more variables.

Other aspects of technical iterations and evolution that arose included those that extended beyond the initial project itself, such as the opportunities for commercialization of some technologies. While these elements can arise as natural next steps for a successful innovation, it can be relatively new territory in a traditional research environment. Sam felt that commercialization “should be considered at the start of a project like this” because as they become successful and grow, the risk of technical changes or financial implications to use the resource may arise if it progresses to a commercial level. Some had concerns about the broader evolution of opportunities, with concerns that updates can become “too cumbersome” and that not everything needs to grow in such a rapid way, that “a very simplistic kind of reporting and capture” can still provide value.

Impact. The final category of perspectives shared in the interviews about innovation centred on the idea of impact, or the potential for impact, as a result of the innovations from the cardiac registry. Four participants used words such as “powerful,” “unparalleled,” and “profound” to describe this, such as Cameron, who believed that an “endless number of clinical questions can be answered” using the registry with the “breadth of clinical information and longitudinal follow-up data with linkage” to so many clinical data sources. The data linkages and breadth of information were also highlighted by Ali who felt that the real value of the rich dataset was in the context that it provides. As Ali described it,

There’s not one type of data that’s of independent value without the other context...you have to contextualize people because they’re contextual beings...in my opinion, you can’t just look at one aspect of a patient’s health and do a deep vertical dive on that without looking around and understanding the context in which that disease or that condition is existing within. That’s context and that’s what helps decision-making work.

Ali also cautioned that the functional interoperability of data linkages that provided this rich context has inherent risks, meaning that there is potentially “a central point of failure” and “interdependence” where if a problem or issue occurs, it can affect the whole system.

Ultimately, participant opinion on the overall importance of technology to the project fluctuated. Many added final thoughts about the discussion, such as Dominik who felt that getting the technical elements right was “absolutely mandatory” because if that piece fails, “you’re wasting your time.” Conversely, Drew stated that while the technology certainly has to be done right, “the technical aspects are not necessarily the things that are going to make or break your success...in the end, whatever you do has to generate value.”

Change

As participants shared insight into the innovations of the cardiac registry project, change and change management were specifically mentioned by seven participants. The seven participants discussed elements organized into categories of change related to the institution, the individual, and planning for change.

The Institution. Change management was identified as part of the institutional infrastructure, yet Riley expressed uncertainty about how effective that was in the current system, questioning “if we really architect it properly or put it in the right place.” To be most impactful, Riley stressed that change needs to be “constantly diffused right into the people doing the work and changing on a day-to-day basis” yet doubted “if we really get the change management to diffuse into the culture of the system.” Some participants felt that addressing change at the institutional level may be daunting and assumed to be too great a challenge, that people “don’t even think to change the existing system... I don’t think it occurs to them that they can.”

From a more focused institutional lens, seeking to solve clinical or practice issues was thought to be an important part of introducing changes to the institutional environment. Ali suggested that the change should be initiated as a solution to a challenge by “solving a problem that they have rather than adding onto the workload that they already have.” While this change can often be targeted at a system or team level, the effect may be felt at the individual level as people may be “more willing to participate because you’re not really adding a burden but actually coming across as a problem solver for them.”

The Individual. The individual level lens on change was also reflected on by Gabe who felt that the timing had been right to implement changes, that the clinical space was “overdue to have a new recording software” and that aligning the change with a clinical need meant that “people who adopted it were really ready for something new.” However, Gabe observed a spectrum of reactions and believed that acceptance of or resistance to the changes “was sort of personality driven” and that the negative influence of resisters “maybe swayed some people who otherwise would have been supportive.” Dealing with resistance can be a challenge for any project or team and Sam approached the challenge in a generalized way, claiming that it requires “a lot of patience” and empathizing with those expected to take on the change as “it’s really hard to take on new stuff.” Ali shared insight from the experience of the change event, expressing that resisters “felt alienated by it [the change]” and suggested that addressing that type of reaction could be key for future projects. Often this comes down to value and considering “what’s in it for them” to ease a common reaction that “change is bad.”

Planning for Change. To navigate the institutional system and the variety of individual responses to change, Drew addressed the need for design and strategy of the change as part of project planning. Drew had learned from experience that “you can’t just build it and they will

come” but to “figure out what they need from the beginning” and then apply a process of building, testing, and demonstrating value. Learning from other industries can be valuable as well, as Drew suggested to “bring in the learning from start-ups...there’s a lot of lessons to be learned from that innovation angle.” Planning and nuanced approaches to change were supported by Ali who felt that “a lot of big projects, ambitious projects fail... because they just brute force it” and that with careful planning you can encourage people to “buy into the concept” and build trust that “it’s going to pay off.”

Innovation: Synopsis

From the interviews, key aspects of innovation were identified with a particular focus on the individual perception of innovation, project design, technology, and change. Perception of innovation was often associated with a participant’s role or experience, whereas innovative approaches to project design and technology were largely thought to be related to an evolution of thought and new ways of conducting research beyond the traditional practices. While the concept of change may be more abstract than the practical application of project design and technology, participants recognized that in order for innovation to take root, change principles must be considered at the individual and institutional levels.

Learning

The final theme that emerged from the participant data was learning. Participants spoke of four main areas that exhibited or supported the learning that was required by a variety of players in relation to the cardiac registry project. The following four sub-themes characterized the learning and educational elements that were observed or experienced by participants: (a) unstructured learning, (b) structured learning, (c) knowing your audience, and (d) lessons learned through the experience of the project.

Unstructured Learning

Unstructured learning was the most common type of knowledge gain or exchange experience that participants spoke of during the interviews. Nine participants shared unstructured learning experiences that included a learn-as-you-go approach and collaboration as learning.

Learn-As-You-Go. Seven of the participants described a learn-as-you-go experience as part of the cardiac registry project. Alex, Sam, Gabe, and Cameron all spoke in a pragmatic way about the learning that they did “on the fly” or “while you’re going through” the process or experience. Some attributed personality to an ability to “pivot and learn as you go,” which required flexibility to “be okay with that” and a positive attitude towards an unstructured situation. Morgan related learning as you go to what naturally occurs “as these kinds of opportunities grow” and new ways of thinking or doing are needed.

Participants also spoke about resources they sought out during the learn-as-you-go process, such as Gabe seeking out the experiences of others “for any knowledge that we could draw on.” Other participants also sought the knowledge of others or found proximity to those who are familiar with the knowledge helpful, for example seeking out subject matter experts or “those who were closest to it.” Cameron explained that proximity to the project team and “just seeing and hearing and talking about how they think” provided opportunities to learn and then try to apply that knowledge themselves. Alex agreed with the value of this, stating “those who are closest to it, know its strengths and uses the best.”

Other resources, such as data and documentation, were also sought out as part of the learn-as-you-go experiences of participants. Quinn described a unique approach to learning-as-you-go as part of the data analysis or extraction process: they would learn and understand new things “as we start looking into the data” which creates a cycle of “learning along with it.” Sam

and Cameron also sought out documentation, such as the data dictionary, to guide what they needed to know, while Blake found online resources to bolster their knowledge through what they described as “self learning.” Similarly, participants recognized that some of the tools and resources that they put together would be used as learn-as-you-go support by registry users, creating a space where they “needed to be really careful what we set out” because they were aware that people would use them as part of their own learning process.

Collaboration as Learning. Collaboration and the iterative process were also identified as helpful aspects of the learning required to contribute to the success of the registry project. The collaboration between data analysts and the project team was considered by Dominik to be “a sort of educational thing” because “we knew the data better than they did” and it became “very much an evolutionary thing” while they shared expertise in order to move forward. Blake agreed that working with registry users offered some elements of the collaborative learning process because “people aren’t exactly sure what they want even when they’re asking for it” which required knowledge sharing and capacity building “to help them understand.” Learning through collaboration can also present challenges, as Kris explained that “it kind of pushes back” to the requestor or user. While that can cause some frustration or delay, Kris maintained that it “helps them develop the skills that they need to understand the full process” and was critical for the research collaborators to “really understand what they need and justify it based on their ethics and documentation” in a way that would not have been possible without building that capacity.

Structured Learning

Five participants provided insight into some of the formal activities that took place to socialize and educate about key elements of the registry project. Alex and Gabe outlined the types of formal sessions that were offered, such as rounds, presentations, department

communications, in-services, and training sessions. Gabe expanded on the formal sessions, explaining that they included not only pragmatic instruction but capitalized on the opportunity to emphasize “why it was important and shared the big picture and the vision” to help support the learning with rationale.

Sam provided further description of some of the formal teaching opportunities that focused on topics such as functionality, data capture, and software upgrades. While Sam felt that “the software was fairly intuitive” it was also helpful to apply new knowledge with someone “who’s well versed sitting next to you” after training sessions. Other sessions focused on broader topics that may have had less pragmatic application, but Drew felt they provided important context for the technologies and tools, such as “intellectual property [IP] protection, legal stuff, and commercial agreements” and that there continued to be “requests to do some workshops around things like basic IP protection.” While a major stakeholder in projects like the registry project, Drew explained that PI’s have zero training when it comes to this.” In addition, Kris shared that “there’s a missing educational component on that [academic] side” and addressing this gap “would be helpful for fellowship programs and residency programs to gain a better understanding of how to work with health information... I think there’s a weakness there.” Effort has been put into bridging this gap in recent years, as Kris described various stakeholders “giving presentations” on key topics and that “the steps are much clearer than they used to be.”

Know Your Audience

Participants who had experience working with users as part of the registry project commented on aspects of understanding the users as part of a successful interaction. These considerations included interview data that illustrates the following categories: assessing base knowledge, finding common ground, and realizing the value of user capacity.

Base Knowledge. In Dominik’s interview, they commented on starting with a basic approach to data consultations with users, candidly saying that “most of our clients have no idea where the data comes from.” Blake also shared this sentiment, agreeing that “they don’t understand the data” and that this lack of knowledge can cause frustration as users then have no concept of the complexity and steps involved in access and use of data. Blake felt that “they typically come in without the full information they need” for the analysts to do their job, yet “they’re kind of just expecting me to pull it out of the hat.” To address this disconnect of knowledge levels between users and analysts, Quinn described that they take care to “explain it differently” to those without data experience, claiming “it will definitely be a different approach.”

The different approaches were captured by other participants as well. Some felt that as you learn your audience, you begin to discover the common perspectives that users enter with, particularly in specialized populations such as physicians or researchers who exercise a high level of expertise within their own domain. It was explained that there are “two different reactions” to a knowledge building process, one that “everything outside of their particular domain is kind of simple” which requires more time explaining the complexity and nuances, and a second common user perspective where they “come in a bit more humbly saying they don’t know anything about these things.” In either scenario, “you do have to educate them” but “with that sort of individual lens,” focusing on both the context of the data complexity and then drawing connections to what their needs are.

Common Ground. A number of participants spoke of finding common ground as a means to adjust for the imbalance in base knowledge of data across users and collaborators. In Drew’s opinion, it was essential to “make it a personalized discussion” and that once you

understood the level of knowledge someone was starting from, you could “try and find that common ground.” Furthermore, Drew found that drawing analogies from users’ own context often bridged the knowledge gap. They used a strategy where you “keep abstracting up until you find a common level where you can begin creating metaphors... or analogies that people will understand and be able to relate to their work.” From Gabe’s perspective, this simply required a conversation to understand user context and needs, showing options and examples, and then the work “gets sort of tailored, or customized, after that.” Finding common ground also required acknowledging differences of perspective, as Blake expressed concern at times about interpretation of the work, noting that crossing disciplines between a clinician and a data analyst required understanding that “we interpret things very differently.”

Value of User Capacity. The effort made to learn about users and establish common ground was recognized as well worth the investment. Beyond the time put in to share knowledge, participants described thoughtful and intentional approaches, such as seeking to understand the various domains that span health science and computer science, as they have “very different ways of thinking.” Participants described the effort to “very quickly learn the different areas to be able to try and find which kind of metaphor or analogy is going to work.” The benefits to users were agreed upon as well. It was believed that gaining buy-in from users “requires that sort of intellectual understanding” that came from this learning process. Drew recalled a similar project to this registry project where “users didn’t know what to do with the data” which meant that “it did not get used as much as it should have.”

Lessons Learned

As the interview discussions explored the learning that took place throughout the project, many participants reflected on their own learning as part of this experience. Eight participants

considered what they had learned, or might do differently in the future, including some of the elements explored earlier in this chapter which were grouped into two categories: people and strategy.

People. Participants voiced two different aspects of the project work relating to people: one about the network around you and the other about intentional collaboration. During the initial work of the registry project when there was no roadmap to draw from, both Gabe and Rene felt they had gained valuable insight into how to approach that challenge, such as “how to navigate through a complex network” and that it was the “importance of coalition building that really helps.” According to Gabe, the first efforts at reaching out through the network for this project often felt like “a hunt and peck exercise” but applying learning from this experience would help in future efforts. Ali expressed interest in ensuring the lessons learned from the experience could be helpful to others, explaining that they had already prioritized “trying to pass on my experiences” and “mentoring others to learn how to navigate the challenges” of this type of complex project.

Selecting who to work with as collaborators is another area that participants felt strongly about. Cameron felt that “it’s really the people, the team, that are everything in this” while Drew agreed that “the people you work with is probably the biggest determining factor for success.”

Drew elaborated on this statement, insisting that in the future:

I would choose who I work with very carefully. If I was to do it again, you get a small, focused, elite group together, essentially, that can work effectively and pull it off the same way you would start a start-up.

While in academia and healthcare environments people typically work within their teams or departments, Drew felt it was time to think beyond that proximal mindset and consider that “the

best people who are most aligned with what you're doing might not be within the environment you're in... find the best people versus taking what you can get.”

Strategy. The lessons learned about strategy included the ways participants would go about attempting this type of project in the future, such as the characteristics, pace, sequence, and preparation for future endeavors. The characteristics of the team involved worked well for the cardiac registry project, yet Gabe homed in on being deliberate about that in the future while reflecting back to the start of “those first meetings... how it has evolved and changed... and the natural ability of the team to just have that attitude of ‘how can we get there.’” Instilling that attitude from the start would be prioritized in the future. Even though it worked in the team’s favour, it truly demonstrated how important that ability to “pivot” and to “think about problems in different ways” was to the success of the project. Both Rene and Gabe isolated a key characteristic they both described as “grit,” explaining that despite the project being a great idea “there were a lot of spots along the way” where “it could just easily fizzle out.” The element of grit meant the push “to just keep going no matter what this barrier was, or setback, or just to figure out how to keep going.”

Other strategic elements that arose when discussing lessons learned included aligning priorities with “understanding what stakeholders need to win,” “anticipat[ing] what the concerns are going to be,” and “get[ting] endorsement from the top” Cameron felt that the sequence in which tasks or priorities are addressed can be brought forward as a future learning, while Blake felt that regardless of the sequence you should “iterate slowly” to ensure that everything put forward is “clear, accurate, and gets distributed to everyone who needs it.” Some actions that may have taken place concurrently could have benefited from having “a separate development and review process” rather than what they felt had been “doing it on the fly.” Overall,

participants had some generic advice for the future, such as Sam stating that he would encourage others to “be bold, big, and ambitious” while ensuring that they are “prepared for a lot of work.” For those who are willing to take it on, “it will pay off.”

Learning: Synopsis

Participants reflected on the learning that had taken place throughout their experience with the cardiac registry project, acknowledging that often the roles of learner or educator fluctuated based on the situation. Ranging from structured to unstructured learning, the need for learning in a variety of forms was widely understood and participants valued flexible, self-driven approaches as well as formal, structured sessions. The importance of knowing one’s audience was emphasized, particularly in complex spaces where multi-disciplinary experts merge and finding common ground is often a key strategy. Finally, exploring the learning that has taken place prompted participants to consider their own lessons learned through the experience with this complex project.

Summary

My case study was designed to gain insight and understanding of the adoption of innovation process and the learning associated with the process of technology transfer in the healthcare environment. Data from 16 participant interviews and eight key documents indicated that four central themes played a role in experiences related to the cardiac registry project. The success of the project was influenced by people, the internal and external environment, innovative aspects of the project design, and the learning implemented to influence change as well as the learning that took place by those affiliated with the project itself. In the next chapter, these findings are discussed in relation to the literature around adult learning, change

management, and adoption of innovation, and reframed by the research questions that shaped this study.

Chapter Five: Discussion

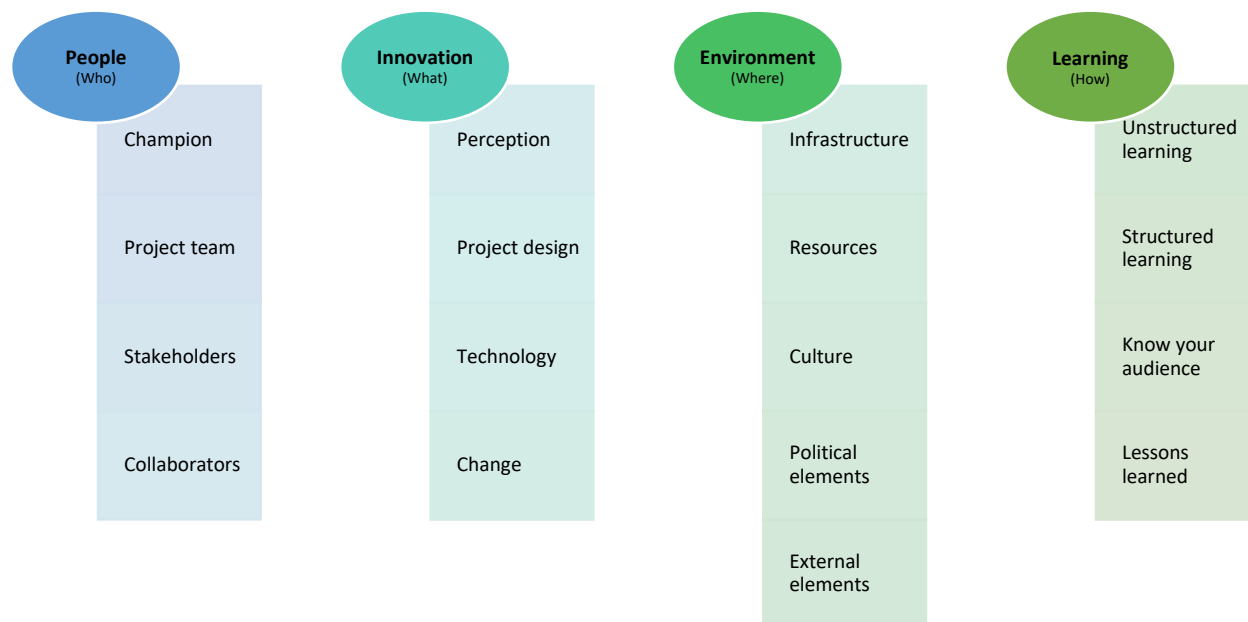
The research questions for my case study were designed to explore the conditions necessary for successful adoption of innovation of data-driven technologies in the health professions through the experiences of those involved in a project in western Canada. Tying in the findings from participants' interview analysis and document review, in this chapter I highlight the four themes and then explore the alignment or divergence from current literature using a who, what, where, how, and when format. Then, I discuss the outcomes of the research questions in relation to this synthesis. I conclude with a brief exploration of additional considerations, revisit the conceptual framework, and provide a review and response to the research questions.

Findings Overview: Four Key Themes

The four themes that emerged from the participant interview data and analysis were people, innovation, environment, and learning. A visual representation of these themes, and the categories within, is provided (see Figure 2) to frame the following discussion about the ways these findings relate to the literature. The themes were regrouped into pragmatic terms of who, what, where, and how, to better link to the evidence in the literature and to address the common questions that arise when planning for design and implementation. A final planning element, when, was added to explore additional aspects of timing, funding, and resource requirements discussed in the literature.

Figure 2

Summary of key themes and categories



The topics of AI and machine learning were not specifically present in the participant narratives. While the topics were explored in the literature review in anticipation of the prevalence and importance to the case study, the experiences and reflections of participants were grounded in relational aspects of the technology, such as how to learn, share, communicate, and design such a project, rather than the technology and its own characteristics and capabilities.

The themes that emerged from the participant data were reflective of key aspects noted in my initial review of the literature on change theory and Rogers' (1962) Diffusion of Innovation. These content areas were crucial in developing the questions for the semi-structured interviews and many of the key concepts and ideas within were evident in the participant data, such as the important of understanding your audience and identifying key stakeholders and collaborators as early adopters or laggards from Rogers' (1962) work. Elements of change, change management, and project design reflected the participants' experiences with how to consider changing practice

and changing behaviours. These four themes, people, innovation, environment, and learning are woven into the discussions in this chapter.

Who: People

The work of innovations and introducing them to care environments is a collective and collaborative endeavor, particularly due to the multidisciplinary nature of health systems (Urquhart et al., 2015; Walker et al., 2020). Innovation is often dependent on behaviour change, yet it may be challenging to predict how to proactively impact individual and collective behaviours. It also involves assumptions about how these behaviours might be changed (Fan et al., 2018; Sarkies et al., 2021). This section reviews the champion as well as the relationships involved in the social, collective, and collaborative environment of health systems and institutions.

Champion

Seminal authors in diffusion of innovation, such as Greenhalgh et al. (2004), and more recent studies (e.g., Cresswell & Sheikh, 2013; Desveaux et al., 2019; Gagnon et al., 2010) have highlighted the importance of having a champion. Champions are described as most useful at a senior leadership level (Cresswell & Sheikh, 2013), bridging the gaps between teams and organizations (Greenhalgh et al., 2004) and facilitating management and staff support, such as re-imagining workflow and prioritizing training (Gagnon et al., 2010). One study (Desveaux et al., 2019) emphasized that while the various factors play a strong role in successful implementation strategies, the transformative changes required to embed innovation into complex health systems requires “creative and bold leadership” (p. 6). The term *bold* is not unlike the drive of the registry project champion that many participants described, however it

was interpreted that the champion is often discussed as someone external to the main project and influential at the institutional level.

Participants in my study almost exclusively identified the principal investigator as the champion, though Parker, Drew, and Gabe did identify other champions from within the institutional environment who demonstrated influential support of the project. Similarly, Flessa and Huebner (2021) suggested that successful adoption processes also included a champion who is an administrative promoter, emphasizing that the support of opinion leaders can have a significant impact. Borracci and Giorgi (2018) found that diffusion of new innovations amongst a group of cardiologists was successful so long as opinion leaders were viewed as supportive. Based on participant Drew's description of how the early iterations of the project maneuvered through the system to gain buy-in at high levels of the organization, it appeared that the registry project was able to accomplish this and Drew seemed to feel that it was a pivotal step in setting the project up for success.

Relationships

Understanding different values and recognizing the roles, individuals, and potential differences across groups of people, such as managers and clinicians, is a key aspect of building and maintaining supportive relationships for innovation and implementation (Ward, 2013). While nearly every participant spoke of champions, teams, and stakeholders, this was also noted in the literature. Ward (2013) emphasized the importance of a collaborative organizational culture, particularly those that demonstrated effective teamwork, in the successful implementation of technology into complex systems. Interactions are not truly across organizations, but center on the interaction between the people who work within them (Cresswell & Sheikh, 2013).

Urquhart et al. (2015) highlighted the social and relationship aspects associated with implementation, such as stakeholder involvement, including the capacity to develop and use beneficial relationships to address the implementation needs of the innovation. In my study, Gabe described how relationships were built over time, while Sam explained the strategy to get people excited about the work. Rene also spoke about how the needs for this innovative project were new for many teams and it became a catalyst for new collaborative working arrangements that were needed to support this kind of work. This focus on relationships and stakeholder engagement was consistent from participant experiences and the literature reviewed for this study.

In earlier work, Fitzgerald et al. (2002) claimed that the diffusion process was significantly impacted by the status and nature of prior working relationships among those involved in an innovation project; in particular, high-quality relationships were thought to counteract the potential effects of challenging contextual factors. The facilitation of these interactions may be key; enhancing connectivity among people may mean more effective mobilization of the resources required for successful implementation and adoption (Walker et al., 2020). To accomplish this, Safi et al. (2018) stressed that communication between key players in an innovative technology project must be improved and simplified. In my study, numerous participants spoke about this, emphasizing the importance of communication tools such as one-pagers, elevator pitches, written documents, and formal presentations. Morgan and Riley felt that sharing communication in “a digestible manner” and in a way that could be easily understood was crucial; the findings from other relevant studies, such as Safi et al. (2018), are consistent with this.

The social aspects of interactions, such as attitudes and behaviours, are critical to balancing the organizational challenges of innovations (Cresswell & Sheikh, 2013). Attitudes and behaviours of key stakeholders towards the innovation are remarkably influential and can affect the overall promotion and adoption by other stakeholders and users (Flessa & Huebner, 2021; Janssen & Moors, 2013). In my case study, Kris and Rene talked about the tension between collaborators and organizations, describing a culture of mistrust that had developed over time between the clinical arm and the research arm of this integrated system. Rene felt that this had improved over time and that efforts to improve processes for innovations had sparked new ways of working across organizations to develop more sophisticated mechanisms for these types of projects. This notion of improved processes, and the need for enhanced collaboration, communication, and infrastructure was reflected throughout the literature on innovation in the health system. Sarkies et al. (2021) described the changes needed at the system and institutional levels, with particular emphasis on the individuals and interactions within the healthcare environment. Other points raised in the literature included the importance of systematic management for healthcare innovations (Flessa & Huebner, 2021), creating the structural conditions necessary for innovation (Palm & Persson Fischier, 2021), and developing the partnerships and networks necessary to most effectively support innovations in and across institutions (Walker et al., 2020).

The importance of leadership and managerial support for an innovation was also indicated by Palm and Persson Fischier (2021), as managers have been shown to create efficiencies and drive collective acceptance as teams become socialized to an innovation. Interestingly, some participants felt that engaging multiple leadership and management level stakeholders early on in the project planning was top-heavy, however the literature (Creswell &

Sheikh, 2013; Safi et al. 2018) indicated that this may be a supportive strategy to demonstrate a positive attitude towards innovation and help alleviate the potential challenges from a high level. Other participants felt that support from high-level stakeholders, such as department heads and executives, was reassuring and would ensure the right perspective to support all levels of project development. From the literature reviewed for this study, along with data from participants like Sam and Morgan, there is agreement that for successful adoption of innovations, people within institutions, and the processes they govern, must be engaged early in the process (Garfield et al., 2020).

Organizations can only perform as well as the individuals and teams that function within them. As such, people interact with one another and with the work of implementation as members of an organization. Since they are expert members and facilitators of the organization and its functional approaches, involving stakeholder groups in the development of interventions is thought to promote adoption and aid in identifying potential barriers (Safi et al., 2018). Ward (2013) also focused on the needs of people in a successful project, such as the importance of consultation and involving end users and representatives from the organization. Many participants in my study shared about how users, clinicians, and key stakeholders from across the two organizations were involved and consulted throughout the design and implementation of the cardiac registry project. Accounts from participants, as well as the documentation, indicated that the project design included many key stakeholders very early on in the process. Participants discussed how best to approach stakeholders early in a project process and emphasized a focus on the impact, demonstrating need, and personalizing discussions to the expertise of each individual. Several participants felt that it is the people who are part of the process that are the critical factor and the biggest indicator of the potential for success of a project.

What: Innovation

Innovation in healthcare and the associated technological advances have been described as an intentional introduction and application of ideas, processes, products, or procedures that are new to the area of adoption and have been designed to provide significant benefit (Garfield et al., 2021). A process-based definition of innovation was presented as “invention + adoption + diffusion” (Kelly & Young, 2017, p. 121). Flessa and Huebner (2021) claimed that there is currently no overarching or generally accepted definition of innovation; moreover, different sectors and fields apply slightly different concepts based on the contextual and industry-specific nuances.

One of the initial pivots experienced early in the interviews of my study was the framing of a question related to what participants felt was innovative about the cardiac registry project. Interestingly, Dominik, Rene, and Quinn provided responses indicating that, based on their area of expertise and role with the cardiac registry project, the project was not necessarily innovative. For instance, Dominik, who felt that what was required of their expertise was akin to a routine or straightforward task, struggled to identify what was innovative about the project and suggested that maybe the innovative aspects of the project were evident in other areas. Notable is the similarity in the positions held by these participants, which happened to be roles within the system that are generally involved with a specific task, request, or review. For me, this raised compelling questions about the nature of innovation, the perception or perspective of those involved, and whether this has an impact on the implementation or adoption process. Perhaps it was simplistic to think that while an overall goal or project may be innovative, individual steps in the process are also innovative, when in reality they may remain rather routine for those involved only at specific points in the project development and implementation.

While Dominik, Rene, and Quinn were challenged by the request to describe what the innovative components of the project were, other participants were firm in their understanding of what they considered innovative, from creating something new to pushing boundaries, as Drew and Kris explained. Flessa and Huebner (2021) described innovation as those that seek to provide something where no current or effective solution exists. Similarly, Desveaux et al. (2019) defined innovation as novel digital products, processes, or business models, yet indicated that developing a definition of innovation at the system level may help to align efforts across the organization and the actors within it.

Distinctions have also been made to delineate innovation from other types of change or improvement that are commonplace as systems evolve. For example, Palm and Persson Fischier (2021) claimed that innovation is about increasing value and generating something novel. From my study, Drew and Kris both held roles with the cardiac registry project that involved a higher-level perspective, so perhaps it is reasonable to consider that the understanding of an innovation may not be evident at all levels or to all individuals. A valuable perspective brought forward by Côté-Boileau et al. (2019) is that an innovation will mean different things to different people across the spectrum of an organization and that this is something to be valued as it reveals important aspects of the innovation and how well it may align with various roles and internal environments.

Innovations are thought to emerge when there is dissatisfaction with the status of current practices (Janssen & Moors, 2013). This was not consistent with participant interviews from my study, as dissatisfaction did not appear to be the catalyst for the innovation. For example, Gabe described the aging reporting system within the clinical environment and felt that introducing the innovation was addressing a current (or upcoming) need for upgrading and improving the

standard of practice. In addition, Parker described designing an automated processing application that would increase the efficiency of data exports in the current technical infrastructure system that was used by the cardiac registry project. This innovation was born not out of dissatisfaction, but from noting and addressing a gap in process. The existence of a problem, or a gap needing to be addressed, is what makes the innovation valuable (Janssen & Moors, 2013). Drew also described this type of like-minded catalyst, sharing how innovative thinking and new ways of functioning can promote other innovations in related or complementary spaces.

Innovation in the healthcare industry also requires a high level of expertise in both technological aspects as well as clinical practice (Cresswell & Sheikh, 2013), a rare feat often managed by collaboration between technical experts and clinical experts. Some participants felt that the champion demonstrated expertise in both of these areas and that this hybrid knowledge base was critical for the success of the cardiac registry project. Ali described a “triad of skills” that also included leadership as part of the champion’s abilities that aided in the project’s success.

Participants from my study described innovation in pragmatic terms, such as the project design, technical components, or the data integration model. From my review, the literature focused not on pragmatic feats, likely because these are contextually specific, but rather explored innovation in healthcare at a more conceptual level that could be applied broadly. For instance, in the literature I found it was emphasized that innovation requires two phases: 1) idea generation, and 2) implementation. It is only when both are achieved that innovation has truly occurred (Palm & Persson Fischier, 2021). How projects, teams, or organizations proceed from idea to successful implementation appears to be the critical step, and it is yet poorly understood. Participants in my study discussed aspects of this pathway not in relation to innovation per se,

but considering the organizational pathways and processes that were required to proceed from idea to practical steps of implementation. These will be explored further in the Implementation section below.

Technology

Technology is a common aspect of innovation as it is often harnessed to provide tools and efficiencies that alter workflows and processes. As a common component of innovation, technology should demonstrate key characteristics of being useful and offering an advantage over current or existing practices (Cresswell & Sheikh, 2013). Much of the literature reviewed focused on adoption strategies and implementation processes rather than on innovation itself, only describing the technology as context for the work being done. Insight into implementation challenges was reported to be largely dependent on organizational and social factors and less to do with the technology itself (Garfield et al., 2021; Guarcello & deVargas, 2020). Similarly, Drew from my study emphasized that the technology was not the critical factor, but how to move through the system and support adoption was the key.

Digitization alone was not generally considered innovative, but simply the effort of an industry to progress and evolve by using widely available tools, such as electronic health records. Upgrading health systems to digitized environments can be argued to be a quality improvement step rather than a novel innovation. However, uptake of digital health tools, records, and processes is still lower in the healthcare sector than other fields and industries (Appel & Hedefjall, 2022; Lai & Mamzer, 2020). This slow uptake demonstrates the need to better understand the factors associated with adoption of digital technologies in these complex systems. As noted in my study, Riley shared frustrations about the slow uptake and lagging processes that

continue to plague the current healthcare environment, including ongoing digitization efforts, as well as more complex innovations like the cardiac registry project.

The focus of some participants on the nature of the technology and the design itself may be due to the specific roles and expertise of the study participants. With a broad sample of participant experiences, from data analysts to organizational executives, the intricacies of the technology and the way in which the technology evolved and iterated is a novel perspective not specifically reflected in the literature. Interestingly, most participants from my study who spoke of the technology eventually came to a general perspective that it needs to be grounded in the local context and be intuitive, useful, and built for the benefit of the end user. In the context of the technology itself, these holistic perspectives are more conceptual in nature and focused on adoption and implementation, similar to the perspectives found in literature, that are further discussed below.

Where: Organizations and Systems

Healthcare environments consist of a complicated and dynamic matrix of inter-related social and technical factors that exist within a wider organizational environment (Cresswell & Sheikh, 2013; Garfield et al., 2021). Innovations are essentially a disruption to these complex organizational systems. Often, excellent ideas, technologies, or products do not find sponsors because the dysfunctionality of the existing system is not yet sufficient for moving innovations forward (Flessa & Huebner, 2021). This dysfunction is widely acknowledged, often described as change-resistant (Côté-Boileau et al., 2019), unpredictable (Janssen & Moors, 2013; Safi et al., 2018), fragmented and turbulent (Garfield et al., 2021).

Discussions on the ideal organizational framework included many similar elements from different authors and different types of innovations, such as management support,

implementation policies and practices, financial resources, and the organizational climate for implementation (Garfield et al., 2021; Palm & Persson Fischier, 2021; Urquhart et al., 2015). Policy interventions have also been identified as an avenue to increase availability of resources and enact innovation pathways (Apell & Eriksson, 2021). In my study, Morgan discussed policies that they believed added alignment to the innovation processes and could continue to be leveraged to offer consistency for support of innovations. Dorr et al. (2018) agreed, suggesting that collective efforts across innovation communities should be leveraged in conjunction with policies that enable and support the requirements for technological innovations. Parker, in their interview, spoke to this collective effort and the ability of numerous organizational roles to provide connected efforts that help move innovations forward.

From my review of the literature, there was limited evidence on how to measure organizational-level readiness and organizational factors that contribute to innovation and implementation, with a gap in theory needed to address organizational and management level of implementation strategies in healthcare (Sarkies et al., 2021). Allen et al. (2017) claimed that no consistent measures had yet been found across studies that attempted to assess or measure organizational factors. To add to this complexity, the focus should be on what would be achieved by the implementation of the innovation, with perspective on the organizational culture and identifying the necessary changes at the structural level (Palm & Persson Fischier, 2021).

The kinds of changes required at the organizational level will continue to be a complicated consideration; design of strategies to affect change in technology and innovation may require a level of understanding beyond traditional aspects of barriers and facilitators (Sarkies et al., 2021). In my study, Rene discussed the evolution of processes at the institutional level, indicating a level of consideration in the institution about the changes that might be

necessary to better support innovative projects. Gabe reflected on the evolution of institutional readiness and an increased sophistication in how different departments and inter-institutional teams now work together to support this work. It was evident from my study that many individuals and roles involved in these processes have acquired on-the-ground experience that they are now applying at the process and organizational levels.

How: Learning

From my review of the literature, I found that many authors included discussions of capacity and knowledge as part of the social exploration of adoption of innovation. Studies such as Cresswell and Sheikh (2013) and Fan et al. (2018) have highlighted social aspects of digital literacy and competencies of users as important to successful implementation, while cautioning that some technologies may inadvertently undermine social hierarchies or challenge existing autonomy. Learning how to incorporate new innovations as part of routine healthcare practice often involves learning-as-you-go and should be supported in ways that fit and respond to local capacities (Côté-Boileau et al., 2019). These informal dissemination strategies may be critical for successful implementation and adoption of innovation (Robert, 2019). From my study, numerous participants discussed the learn-as-you-go nature of the cardiac registry project. Notably Alex, Sam, Gabe, and Cameron shared experiences of incorporating new practices over time and responded positively to the flexibility of learning in a way that fit within the work they were doing at the time. Quinn described this as a cycle of learning along with the data as analysts became more familiar with the project, data sources, and needs of the project with each iteration or request.

Ability to adopt was factored in by Ward (2013) who described an individual's tendency to adopt as dependent on awareness, interest, and ability to trial the innovation. Effective

strategies for learning across the intended population also included formal encounters that allowed for dialogue and problem solving as well as informal communication across a variety of users and innovation experts (Côté-Boileau et al., 2019). Participants who were team members of the registry project shared the efforts to promote the work and provide formal and informal learning opportunities, and described the work done to introduce the technology in a way that supported new users to adjust to the new practices of the workflow.

In the context-specific sector of healthcare, Walker et al. (2020) explained that practitioners are often autonomous in building their own knowledge through experience. It is important to recognize that all partners in a program or system have knowledge — often partial or different — but that through collaboration and exchange, knowledge from all parties is essential to creating meaningful and actionable pathways forward (Walker et al., 2020). Learning has also been described as a social process with multiple steps or phases. Through this learning an organization develops tacit knowledge from the environment (MacVaugh & Schiavone, 2010). Tacit and incidental learning, though subtle, is a means of informal learning that has been acknowledged as holistic knowledge that is created and drawn upon as learners experience the world (Kawalilak & Groen, 2020). In my case study, Dominik spoke of this type of informal knowledge building as related to the collaborative experiences that were part of the evolution of the cardiac registry project, which was reinforced by Blake as he described knowledge sharing as part of his engagement in the project work. Building the capacity and capabilities of individuals at all levels of an organization and system are important to the adoption of any innovation (Walker et al. 2020). Safi et al. (2018) reported that transfer of knowledge and skills as well as understanding the practical impact on healthcare outcomes was a critical part of the learning

process. Kris described a back-and-forth collaborative exchange that continued until the range of skills and knowledge to support the work had fallen into place.

Implementation

Effective implementation is said to demonstrate consistent, committed, and skilled use of an innovation (Urquhart et al., 2015). The ability of an organization to support successful implementation of innovation often depends on how complex the internal structure of the organization is as well as the quality of intra- and inter-organizational relationships (Urquhart et al., 2015). Successful implementation of an innovation requires that players understand how and why organizations adopt new innovations, with specific understanding of the capacity of the organization to deliver and sustain innovations over time (Allen et al., 2017). Implementation also requires flexibility with a blend of project management and pragmatism to continue progressing in the face of unforeseen issues and opportunities (Walker et al., 2020). In my case study, Gabe described the many pivots and iterations that were required as the project encountered issues or challenges. Rene also described the characteristics required to push through in the face of unforeseen issues and identified grit as a key component to implementing innovations in challenging contexts.

Allen et al. (2017) described an organizational climate as indicated by “shared receptivity to change” (p. 18). This line of thinking was informed by examining constructs related to change, including compatibility of the change with organizational values, perception of priority of the change, incentives for meeting change goals, the culture of the organization towards learning, and the state of readiness of the organization to support implementation (Allen et al., 2017). Prioritization may be pivotal at this point in the local organizational climate; both Morgan and Quinn highlighted the challenges of prioritizing new project innovations during such a

challenging time in healthcare and within the organization itself, citing competing priorities and heavy workloads.

Adoption

While much of the literature focused on nuances of innovation and implementation, Allen et al. (2017) also discussed adoption, defining it as “the decision of an organization or a community to commit to and initiate an evidence-based intervention” (p. 18). This was differentiated from implementation, which involves how an organization puts the innovation to use (Allen et al., 2017). Desveaux et al. (2019) encouraged use of change management strategies to facilitate the iterative and complex interactions associated with adoption of digital health innovations. Participants in my study discussed elements of change and change management relating to the institution, the individual, and how to plan for change. In my research, Riley questioned whether the spirit of change management had really been instilled across the institution, while Ali felt that the easiest way to introduce change was to alter as little as possible in the day-to-day workflow of end users and potential adopters while focusing on demonstrating value that will be seen as a benefit or advantage. Adoption approaches are said to vary based on a variety of innovation factors, including aspects related to the specific innovation, the barriers and enablers anticipated, and the current knowledge level of the system and the individuals within it (Walker et al., 2020). Essentially, the same approach to adoption of innovation cannot be used all the time or in every situation (Walker et al., 2020).

Adoption, like implementation, is non-linear. It is also described as participatory and resource-intensive (Walker et al., 2020). Safi et al. (2018) also used synonyms such as acceptance, rather than adoption, describing it as “an unpredictable construct” (p. 2). That study found that acceptance was influenced by differing factors depending on the role of the individual

(Safi et al., 2018). They found that acceptance by managers was most impacted by the interoperability of the innovation and the expected outcomes, while clinicians found usefulness and productivity most important (Safi et al., 2018). This is consistent with the experiences of the participants involved with the cardiac registry project. While managers such as Morgan often focused on the system and organizational alignment, clinicians like Alex spoke primarily about clinic workflows and how the innovation would impact the clinician and patient experience. Others, like Gabe, maintained that there were personality aspects to those who accepted or adopted the changes, though this was less visible in the literature than the more pragmatic factors outlined above.

Navigating Challenges

Studies have explored the implementation of innovation in healthcare systems and identified similar challenges in navigating organizational structures. Urquhart et al. (2015) described a lack of clarity in the roles and responsibilities of the organization: this contributed to governance challenges in understanding who owns what and who is responsible for the various steps and approvals associated with an innovation. Rajkomar et al. (2019) confirmed the difficulties of determining custodianship of various data sets, and the complexities this adds to an already challenging landscape. In my study, Gabe spoke about this at length during the interviews, describing the challenges with navigating a system that may not be built for the work you are trying to do and the difficulty in moving forward when it is uncertain who to reach out to or where to go next.

Problematic aspects of health system organizational structure that often impede successful implementation include IT infrastructure, policy environment, history of limited collaboration, and weak working relationships across organizations (Urquhart et al., 2015). In

particular, issues around privacy and data ownership, including data sharing, tended to cause delays as data continues to be difficult to access and share from existing healthcare infrastructure (Dorr et al., 2018; Urquhart et al., 2015). While challenges in implementing the innovation can often be navigated, using data from the healthcare environment continues to present delays and discontinuity. Kelly and Young (2017) claimed that governance of health data had become more complex than required, with organizations so risk-averse and inflexible that systems are unable to meet the needs of patients or supply the data required to implement novel innovations. In my case study, numerous participants described organizational challenges related to data use, such as Quinn who explained that the skill set of requestors was often incongruous with the data that is actually in the system. Quinn also identified delays due to workload with only so many skilled analysts able to retrieve data and that variation in prioritizing what gets done is based on decisions made at leadership levels. Rene also raised important considerations in aligning with both institutional policy as well as government regulations. Ensuring accuracy and compliance at these levels are crucial and are steps that take time.

Kelly and Young (2017) and Palm and Persson Fischier (2021) identified the importance of failure, that accepting failure as part of the innovation is not a problem but part of the process that must be expected and anticipated. In my study, Riley shared that many innovation projects fail and yet they felt that little had been learned about how to approach these projects or the system processes differently. In that interview, failure was not necessarily viewed as an expected and accepted step, but as a true failure that may have been dependant on extraneous factors rather than because of the lack of value that could have been provided had the innovation project been successfully implemented. Ali felt that strategy may have been the catalyst for failure in

some projects and that careful planning and the right selection of stakeholders can mitigate some of the potential avenues for failure.

When: Timing

The workloads and context of daily realities in the healthcare environment are laden with complexities. Most professions and jurisdictions across healthcare sectors have been functioning in an almost constant state of uncertainty as populations age, staff shortages are commonplace, and burnout and professional fatigue increases. The COVID-19 pandemic shone a spotlight on many of the complexities within the system, but while awareness of the state of healthcare may have increased, the negative effects on healthcare workers continues to press on. Cresswell and Sheikh (2013) encouraged decision-makers and innovators to introduce new innovations and technologies at a time when there are no other upheavals in the organization or when workloads may be adjusted to account for new processes and learning. Considering the current state of many health systems, waiting for this type of opportunity or ideal timing may be unrealistic. Similarly, Walker et al. (2020) pointed out that contextual factors are emergent and dynamic and difficult to predict as well as to influence.

Despite complex challenges in choosing when to introduce an innovation, certain timeframes may be considered a window of opportunity in which certain contextual factors or local considerations may improve the likelihood that an innovation is accepted (Janssen & Moors, 2013). In my study, Morgan, Rene, Quinn, and Cameron shared the challenges of finding a window of opportunity as the health system continues to struggle with staffing, increasing workloads, pandemic-related impacts, and an increasing culture of burnout. Careful and collaborative planning and focusing on solving a problem or improving a process, as Ali described, may be a useful strategy.

Adoption of Innovation: Other Considerations

From my review of the literature, I identified additional topics that had either little or no direct connection with results from the participant interviews, but whose relevance to the overall topic was meaningful and warranted inclusion in this chapter. Below I introduce additional considerations of budget, tension, intellectual property, implementation as science, and evaluation. Though some of these were alluded to in participant interviews (e.g., resources as a budgetary item), few became full categories within the analysis process. This could, in part, be due to the semi-structured nature of the interview questions that were based on the initial literature review. It could also be a reflection of the priorities and ways of thinking about innovation at the time of the cardiac registry project development.

Budget

A critical factor noted in the literature that was not addressed directly in the participant interviews in my study is the cost of innovations and challenges in budget allocation when supporting existing systems yet seeking to expand to new innovations. The costs of innovations can be high as they generally necessitate additional phases of work, from learning new techniques to changing existing system structures (Flessa & Huebner, 2021). Allocating part of the regular budget to innovation-related costs should be incorporated into routine institutional planning (Palm & Persson Fischier, 2021) in order for new innovations to flourish and spread across the intended scale (Kelly & Young, 2017). While budget related to the cardiac registry project was not directly discussed by the study participants, it is clearly a critical aspect of innovative projects. It was considered that the cardiac registry project appeared to have adequate funding and therefore the financial considerations may not have been particularly notable in participant experiences.

Tension

The capacity of an organization to support innovation involves a balance between flexibility and control (Garfield et al., 2021). Allen et al. (2017) referred to these constructs as the tension points for change. In my study, Kris used the word “tension” throughout their interview when discussing the delicate balance between such constructs. Many participants raised discussion points about features of innovation and implementation that exist in tension. While Kris was the only participant to describe it specifically as tension, and identified various features that exist within this space, other participants also raised key issues that align with this dialogue. Morgan talked about the balance between organization policies and project needs while Rene spoke of the difficulty navigating between privacy regulations and data sharing expectations. Parker shared insights into the balance between the needs of researchers and the functioning of the clinical space. The participants’ descriptions of tension are consistent with reports from the literature, such as the need to also balance the design and integrity of the innovation with adjustments that may be required to promote adoption (Côté-Boileau et al., 2019). Kawalilak and Groen (2020) discussed the tension experienced by adult learners and educators as new knowledge and learning opportunities may conflict with biases and assumptions related to the practices and experiences developed over time.

Intellectual Property

Intellectual property is an evolving topic in the field of healthcare innovations, particularly due to the climate of engagement and collaboration that has been emphasized as a key component in successful implementation projects. Kelly and Young (2017) insisted that offering fair treatment of intellectual property to innovators is a crucial aspect for promoting innovation more broadly across an organization or system. Issues that arise from intellectual

property disagreements tend to stifle great ideas rather than realizing their potential (Kelly & Young, 2017). In projects such as the cardiac registry project, where early engagement and collaborative, iterative design were foundational processes of the project, creating clear expectations and transparency around intellectual property may be key.

Implementation Science

The field of implementation science surfaced as an emerging field of study dedicated to the uptake of proven interventions into routine practice (Sarkies et al., 2021). Implementation science was also described by Boulton et al. (2020) as fundamentally pragmatic and focused on changing practice through interdisciplinary collaboration. The field has also been credited with improving the acceptability of qualitative methodologies in evidence-based healthcare (Boulton et al., 2020). Conceptual frameworks can be a critical tool that may aid in guiding implementation outcomes through the selection of appropriate strategies, yet many challenges remain, such as choosing the appropriate framework and translating it into the implementation design (Powell et al., 2017). Appropriately assessing the context and the settings in which the implementation is to be embedded is also a key consideration when selecting an implementation strategy (Powell et al., 2017). Uptake of implementation science in research and change management teams is essential; funding agencies have begun to prioritize studies dedicated to improving the timeline to move research evidence into real-world settings (Waltz et al., 2019).

A common model for implementation science is the Consolidated Framework for Implementation Research (CFIR), which was designed to aid in the assessment of key contextual factors (Damschroder et al., 2009). The CFIR provided a framework to assess characteristics of the innovation, such as those proposed by Rogers' (1962), aspects of the outer setting, inner setting, characteristics of individuals, and process (Damschroder et al., 2009). An updated CFIR,

informed by user feedback, included revised construct names and definitions intended to make the framework applicable across a wider variety of settings and types of innovations (Damschroder et al., 2022). Whether these updates adequately reflect the technological innovations associated with similar progress in data science and use is of further interest for future phases of this work.

Whether the use of a framework, such as the widely used CFIR, would have adequately addressed the technological innovation, and subsequent tensions noted during implementation of the cardiac registry, is uncertain. A key consideration for use of existing frameworks for projects like the cardiac registry is the focus on technology, which may need to move through a system in previously untested ways and may require establishing new pathways and mechanisms for success based on the novel designs inherent in innovation itself. This movement of the cardiac registry project through new pathways was described by Gabe, Ali, and Riley during the participant interviews. However, as adoption of innovation theories specifically designed for healthcare environments are sparse, using tools from implementation science to support change practices in clinical spaces may provide additional benefit and warrant further exploration.

Evaluation

Evaluation must become an ingrained part of the innovation process. A focused and pragmatic evaluation of innovation projects may help organizations, project teams, and key stakeholders better understand success and mitigate challenges for future projects as it can be difficult to differentiate “flowers from weeds” as projects mature in these complex spaces (Kelly & Young, 2017, p. 124). It is important to identify and understand the many factors associated with innovation in the healthcare environment using a balance of soft and hard metrics, such as a combination of monitoring and feedback as well as reviews of quantitative metrics (Côté-Boileau

et al., 2019). Vanneste et al. (2013) also advocated for evaluation of the learners through the implementation process and post-adoption to better understand the outcomes of the learning. From the interview data and documentation, there is no evidence of a systematic evaluation of the cardiac registry project, however as an active and evolving innovation it may be difficult to pinpoint a milestone or timeline for direct measurement. The institutional partners that have also continued to evolve as these innovative projects spark new needs and resources may have developed templates or evaluation resources that can be used for documenting processes, impact, and outputs of projects like these.

This section highlighted some additional areas of focus that were noted in the literature and were relevant to the case study yet did not specifically emerge as a theme or category from the analysis of participant interviews. The importance of budget, intellectual property, and evaluation are arguably critical to any health system innovation. Considerations of tension between players and priorities as well as the potential benefit of incorporating aspects of implementation science were also presented. Next, the research questions are revisited to explore how the findings, analysis, and additional considerations help to address these questions.

Addressing the Research Questions

Based on the participant interviews, document analysis, and review of the literature, the following sections consolidate what was learned in response to research questions that guided this inquiry.

Conditions for Successful Adoption of Innovation

The first research question was focused on the conditions required to support successful adoption of data-related innovations in the health profession. The four themes that emerged from the participant interviews help to summarize the needed conditions. These themes, though broad

and complex, provided context for the conditions that were in place for the successful adoption of the cardiac registry project. The conditions included the innovation itself, implemented in a suitable environment with the right people and supported by effective learning strategies. While straightforward to list as such, each of these conditions requires comprehensive, thorough, and often painstaking detail to assist in supporting overall adoption.

While each of the participants spoke of the aspects of the project that had, in their experience, contributed to the success of the cardiac registry project, many also spoke of the challenges that had weighed down or slowed other projects in the healthcare space. Ali spoke of the conditions as “ingredients,” that it is not just the individual components of the project or process, but “it’s also the art of the whole process.” This is reminiscent of a common healthcare phrase that describes “the science and art” of medicine, of nursing, and so on. Similarly, Knowles (1980) described andragogy as the art and science of adult learning, a phrase likely familiar to many in the industry. The balance of science and art speaks to the tension and balance described by Parker; this kind of work is as much about understanding opposing forces and finding the delicate space between them as the pragmatic work itself. Authors such as Garfield et al. (2021) and Côté-Boileau et al. (2019) described this tension, though ultimately it was Allen et al. (2017) who pinpointed the balance of this tension as the impetus and opportunity for change.

Learning as Support for Innovation

The second question focused on the role of learning as support for innovation. Every participant spoke of learning, whether it was how they came to build their knowledge or the identification of gaps in their skills or even collective learning needs related to institutional pathways and processes. Some learning was familiar and straightforward, such as the structured, formal sessions described by nine participants, including Gabe, Alex, and Sam, or the learn-as-

you-go, trial-and-error styles of unstructured learning experienced by Cameron and Quinn. These learning opportunities created the foundation for collaborators and end users and ultimately contributed to a collaborative system that was designed to support implementation and adoption.

The organic, unstructured learning was a focal point for many of the study participants. The industry standards in healthcare and the norms of practice likely contribute to the familiarity, and even preference, for this style of learning. Alex spoke of the ease and flexibility of building skills as part of the workflow while Quinn described the self-directed learning approach of applying knowledge as they continued learning from the data as it became available. Kris, Blake, and Cameron all spoke of the collaborative process as understated learning opportunities that allowed multidisciplinary collaborators to learn from one another and build a network of supportive individuals with expertise that spanned the necessary content areas, from cardiology to data analysis.

The literature on learning as support for innovation and implementation showed extensive synergy with what was expressed by participants. Just as participants discussed collaboration as a fundamental source of learning, MacVaugh and Schiavone (2021) identified learning as a social process where knowledge acquisition often evolves as one takes part in the contextual domain where the innovation is implemented. Walker et al. (2020) also described the success of innovations as relative to their spread through a collective and collaborative social space, while Sarkies (2021) described the collective behaviours and activities required to support these types of initiatives. While there are no specific or directive recipes for how best to design learning in the face of new practices related to innovation, the learning of participants was best supported by a network of collaborative individuals, engaged in social processes, and contributing to collective knowledge and behaviours that would ultimately support change.

Experiences of Innovation and Change

While the third research question was potentially more difficult to answer, perhaps that is what makes the question valuable as I sought to find meaning through experience. In their interview, Ali spoke of the importance of experience in building confidence and credibility within the collaborative community, but also emphasized the importance of sharing that experience with those just starting out in their own innovative project journeys. Similarly, Gabe spoke of wishing there had been others to learn from in the beginning of the cardiac registry project process and how that has shaped their willingness to share their experiences with others. There is much to be learned from others, and that is part of how we, as professionals and social collectives, continue to improve.

The experiences of study participants involved in the cardiac registry project demonstrated the need to create new pathways, overcome challenges, find allies and partners, maintain strong relationships, rely on one another for learning and project progress, and to continue to find ways to move forward when things seemed impossible. All of these aspects of innovative work require, according to my analysis of participant experiences, two key things: 1) motivation, grit, and determination; and 2) people that support, problem solve, bolster, and champion. This work cannot be done in isolation, and despite the technological innovations and impressive capabilities of what can be produced when data and technology are harnessed for the purpose of improving care, it is the people who influence the experience and the overall outcomes.

It is this perspective that brings the research questions back to social constructivism and reaffirms the foundation of viewing this topic from a collective, social perspective. Ward (2013) and Dorr et al. (2018) emphasized collaborative organizational culture and social collectives as

imperative for success, while Apell and Eriksson (2021) identified communication between individuals and teams as paramount to implementing AI in healthcare systems. In their own study, Borracci and Giorgi (2018) noted the importance of both peer influence in social knowledge-building processes as well as the ability for social leaders to positively or negatively influence others. Despite the years of expanding knowledge about implementation, organizations, and innovations, perhaps the simplest explanation, as explorations of these environments continue, is that people and relationships are still the ultimate factor for collective success. Particularly in healthcare, as in other public domains and in contrast to some corporate or industry standards, goals are generally based in the good of society as health innovators seek to improve care and positively influence the lives of patients. In that sense, the participant experiences and the intended project outcomes were rooted in collective effort for collective gain.

Conceptual Framework Revisited

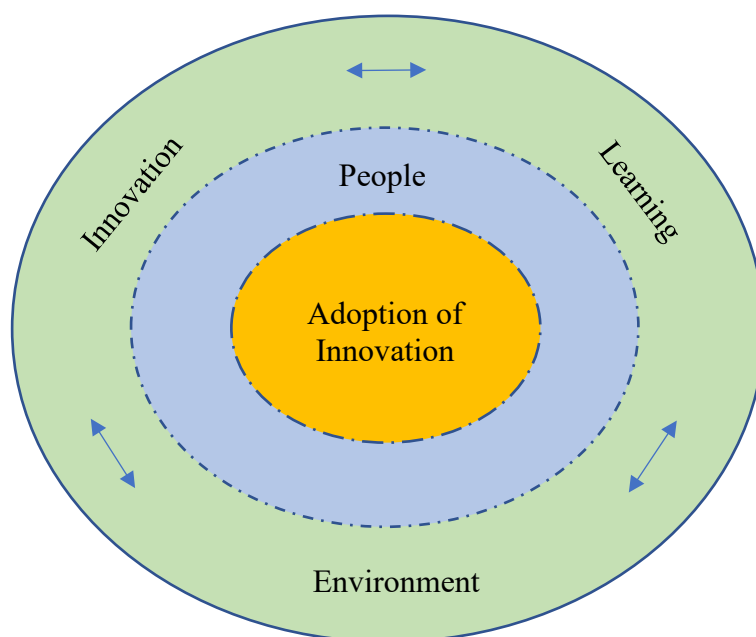
The conceptual framework presented in Chapter Two illustrated the anticipated intersection of theories key to the purpose of the doctoral study. The initial framework presented anticipated that Rogers' (1983) Diffusion of Innovation and change theory may be found to provide foundational knowledge to inform the strategies for learning of a change event, in this case the cardiac registry project. Moreover, Rogers' (1983) model and change theory were influential in designing the data collection tool that uncovered key aspects of the participant experiences.

Upon reflection on the evolution of the doctoral project, the findings, and the analysis, a revised model is proposed that reflects the perspectives of the study participants. In this revised model, the key themes from the participant findings are used to illustrate the major components

of an innovative project in the healthcare environment, demonstrated in Figure 2. In this revision, people are the main component as they are the key drivers designing, enacting, supporting, and facilitating the innovation project, the learning strategies, and the pathways and regulations of an institution or environment. There is interplay between the main themes (people, environment, innovation, and learning) with aspects of innovation influencing learning strategies or triggering the necessary institutional processes, all taking place between teams, networks, and relationships, with an end goal of adoption of innovation.

Figure 3

Revised Conceptual Framework



The work and quality required in the innovation itself, in the learning opportunities, and in the environmental (institutional) pathways and processes are critical for success. However, the people involved in those spaces will ultimately affect the success of any project. Environmental factors, learning activities, and project designs alone will only be as effective as the individuals

and teams responsible for that work; often, it is the relationship between actors and across teams that holds the key to success.

Summary

Innovation itself is a journey that embodies the unpredictable nature of the healthcare environment, dependent upon dynamic and non-linear processes. The potential factors at play for any attempt at innovation in such a space will undoubtedly face a range of complexity, from the social relationships amongst individual players to the broader organizational infrastructure and healthcare environment. Exploration and understanding of the organizational dimensions in the implementation of technological innovations is not a clearly defined area of study (Cresswell & Sheikh, 2013). There is currently no comprehensive framework that conceptualizes the implementation and adoption of innovations in this sector (Cresswell & Sheikh, 2013), nor is there a consensus on the combination of conditions that are thought to enable the adoption of healthcare innovations (Côté-Boileau et al., 2019). In this chapter, I have discussed the core features of an innovative project implementation by incorporating the perspectives of study participants and reflecting on key insights from the literature. In the next chapter, I provide comments on the successes and challenges of the study and a brief overview of the findings, with implications for practice, policy, and future research.

Chapter Six: Summary and Implications

In this chapter, I review the summary findings that emerged through this study by highlighting key learnings about the adoption of innovation based on the experiences of team members and collaborators of a cardiac registry project in western Canada. I also outline the challenges and successes encountered in the conduct of this study. Contributions of this study to relevant areas are discussed, with a focus on the major learnings and how these might be used by project teams and institutional leadership in similar contexts for potential applications in practice and policy. Finally, I consider how this study aligns with related research and suggest a potential trajectory for future research opportunities.

Overview of the Case Study

The purpose of this research was to explore experiences of adoption of innovation through team members and collaborators of a cardiac registry project in western Canada. This qualitative study used Merriam's (2009) approach to case study to explore a bounded case with all participants having had a role or collaboration with the same innovative project. Using semi-structured interviews and document analysis, 16 participant interview transcripts and eight documents were reviewed, analyzed, and organized into themes. Through this process, identification of key factors and conditions for success surfaced, with the findings organized into four main themes: people, environment, innovation, and learning. While research on this specific topic is minimal, sufficient insight was gained from a review of literature in the relevant areas of AI in healthcare, change management, adoption of innovation, and implementation science. The discussion of the findings of this study highlighted many consistencies with recent literature in these areas and confirmed many of the insights gained from the participant experiences.

Challenges and Successes of the Study

This research project took place during a difficult time and with that came relative challenges but also successes that were made more impactful by the journey. The most significant challenges in the conduct of this study were the timeline delay and sample revision because of the COVID-19 pandemic. While navigating this disruption was challenging, it was a minor inconvenience considering realities during this time. Furthermore, the shift in topic and adjustment of the research questions and target audience did not affect the quality of the study or the ability to learn meaningful things about adoption of innovation related to the chosen case study. It was considered beneficial to adjust the study population to focus on the design and implementation and to include the perspectives of project team members, collaborators, and institutional staff, management, and leadership. These diverse perspectives offered rich insights about the adoption of innovation in this case, yet the initial challenges of the delay and pivoting the initial design are recognized as a significant event in the conduct of the study.

The first aspect I consider a success is that recruitment resulted in many busy healthcare professionals eager to engage in the interviews. While the target population was shifted to avoid placing a burden on frontline clinicians, the COVID-19 pandemic was a significant event for all involved in the health sector. The pressure on the health system was tremendous and the ripple effects were and are still being felt by staff and leadership in all areas. For this reason, the success of gaining enough participants to explore the case study fully was a great relief. The sample acquired for this study was not only sufficient to address the research questions, but the enthusiasm and willingness of participants was interpreted as a level of interest in the topic and a confirmation of relevance to their work. The willingness of participants to engage in this study was a key success during a complex time and allowed for execution of the work.

A second aspect of success that I consider a great privilege is the experience I gained in the conduct of this study. Interestingly, the case study I selected was not directly related to my professional role at the time of study design. Due to a change in role that took place during my doctoral program, not only did the case study become even more relevant to my work, it has become a foundational example of what my team is working towards creating in the broader cardiac environment in our region. The experience of exploring this case study, of gaining an understanding of the pathways and processes, and having the opportunity to discuss the case study with so many enthusiastic stakeholders was an enormous benefit to my role, to my program of study, and to my ongoing development as a professional.

Contributions of the Study

Summary of Key Learnings

The findings of my study were presented and discussed in relation to four main themes: people, environment, innovation, and learning. The study participants discussed many important considerations for how to navigate the challenging landscape of the healthcare and academic spaces in the development and implementation of an innovative cardiac registry project. While a quality innovation itself was considered an obvious component for success, what transpired from the themes of environment and learning were primarily congruous with the theme focused on people: that the individuals, teams, and relationships within each theme are a key component. For instance, when participants spoke about learning, they often spoke about learning from others; when participants spoke of the environment, they frequently spoke of the relationships and networks that created and enabled (or complicated) the institutional processes. The revised conceptual framework, presented in Chapter Five, was adjusted to capture the essence of what was learned during the exploration of this study.

Implications for Practice

Through the findings, analysis, and discussion, several recommendations are presented in relation to each of the four themes regarding implications for practice. The results of this study are not intended to be generalizable, however some learnings may be relevant for project teams implementing innovative technologies in similar contexts.

People. It is critical to identify champions at a variety of levels and institutions to facilitate forward movement through the project pathway. High-level champions often hold influence over broad groups of individuals and teams; this buy-in can be of great value as project teams socialize their work across the relevant institutions. The primary project champion, the principal investigator, was identified by many participants as an individual who was pivotal for success. The characteristics of champions and other influential stakeholders included persistence and flexibility, particularly in demonstrating the ability to pivot and be nimble as changes or challenges arise. Identifying champions and key stakeholders with these characteristics is essential.

The importance of communication within teams, across departments, and across institutions is also evident in the study. Collaborators often mentioned the need for digestible information that highlights pertinent aspects of the project, the specific request or need, and the potential impact of the overall work. This information allows collaborators who may not have detailed knowledge of the project to quickly identify the needs of the project and how this might affect their team, staff, or workload, allowing them to put the request into context of the overall goal and the potential benefit that the project is working towards. Brief written communications are especially helpful for those only involved in specific steps of a project lifespan or for those

who are not involved in the day-to-day work and may use these written overviews as a recap or review as requests arise.

Environment. Establishing the infrastructure and maintaining the conditions required to support teams and innovative projects requires multi-faceted investment from leadership and organizations. The development of policies, allocation of resources, and presence of nimble processes were highlighted by participants as key factors for success, which were also noted in the literature.

The culture of an organization is an important element and influences how individuals and teams function and interact. The organizational culture can often influence daily tasks and the value placed on prioritization, communication, and working styles. This can have a tremendous effect on the potential for success of an innovative project implementation. Participants emphasized the importance of relationships with individuals in the organizations to learn how best to interact with and navigate the nuances of the organization and proceed through the relevant avenues and infrastructure.

Innovation. Most of the participant discussions, as well as literature commentary, on innovations themselves were rather straightforward: it should work well, be easily integrated into the workflow, and have a user-friendly design to better support adoption. The design of an innovative technology should be informed by the user, as well as other relevant stakeholders, to ensure that these features can be realized. A sound innovation that addresses an important need, creates an efficiency, or improves care or patient outcomes is a critical step to generating buy-in as teams attempt to engage stakeholder groups. Creating motivation and excitement will often be dependent on communicating the potential end goal or overall impact of the innovation to key audiences.

Learning. Establishing strategies for educational development, skill building, and instructional supports in the implementation of new technologies in healthcare is crucial. Responses from participants indicated that their positive experiences with the project were significantly impacted by learning critical information through a variety of methods including formal and informal sessions, organic self-directed learning, learning from others, and reviewing documentation. Contextual relevance was considered particularly important in learning processes, with participants keenly acknowledging the benefit of knowing your audience and designing activities and information for the role and knowledge base of the user.

Implications for Policy

Government and institutional policies have a tremendous effect on the use of data, application of technologies, and pathways for implementation and as such are integral considerations for any innovation project. Desveaux et al. (2019) identified recommendations for policy that emphasized the role of government to create a model and foundation for innovative work throughout the healthcare system. This included recommendations that align with the participants' experiences from my case study, such as understanding organizational needs and pathways and focusing on change management (Desveaux et al., 2019). This was also recognized in the literature by Kelly and Young (2017) as well as by study participants as they discussed the importance of adherence to privacy legislation and institutional policies.

As many health system policies may not reflect new uses for patient data made possible by digitization of patient health records, there are implications for studies of this nature to inform new policies that allow for increased and efficient access to data. These new possibilities for patient data must be recognized in policy and legislation to allow researchers and innovators to help meet evolving patient needs and the realize the potential of how advanced data tools can

positively impact patient care. Nambisan et al. (2019) highlighted the benefits of improved policies to create more efficient and effective use of data and that an openness and affordances for innovations will not only provide benefit for patient care, but for the institutions and actors within the overall health ecosystem.

Scarborough and Kyratsis (2022) explained that the tension between nimble innovations and a risk-averse system requires a combination of top-down and bottom-up approaches; innovations can only be adopted, spread, and sustained if the governing policies provide regulatory structure that reflect the conditions needed those on the ground floor of project work. This remains a challenge in most healthcare ecosystems and needs to be addressed to ensure positive benefits for both systems and patients (Scarborough & Kyratsis, 2022). Future work may benefit from a more thorough understanding of this tension and the development of frameworks, guidelines, or recommendations for how to optimize the potential of big data and technological innovations while ensuring institutional policies are updated and upheld.

Directions for Future Research

My study builds on a variety of published work from a range of practice and research areas, such as Fan et al.'s (2018) study of behaviour and adoption of technology and Desveaux et al.'s (2019) work in understanding the factors of acceptance and resistance to new technologies. The relationship of my study to prior research places it within a nuanced and contextual intersection of studies that often examine innovation and technology in healthcare, implementation science, or change management in the health sector. For instance, while Palm and Persson Fischier (2021) explored perspectives on innovation implementation among management, there are further opportunities in exploring other roles and examining differences or alignments based on staff and leadership perspectives at all levels. While my research includes

participants within a variety of roles, this study does not address the gap in understanding the different perspectives and studying how best to use the skills and support the collaboration of those involved.

Innovation

Future research could replicate this study with other technological innovations and develop a more generalized set of recommendations to guide practical project steps and craft frameworks for success. Other replicable aspects of this study include the value of diverse participants with different roles across the main institutions involved. Continued and broadened explorations from all participants who influence and facilitate this type of work will better inform next steps as innovations continue to permeate the healthcare environment.

Further work could also explore the nature and definition of innovation within the relevant environments of healthcare and research as well as the institutional influences and processes for supporting innovation. As discussed throughout this dissertation, there are varying degrees of innovation, some focused on technologies, while others framed more loosely around anything new or novel in the healthcare space. Research that continues to help define and structure the discourse in this space will be valuable.

Evaluation

Both project and outcomes evaluations would add tremendous benefit to the growing literature on this topic and the related areas of implementation science and change management in healthcare as innovation continues to grow in these fields. While many evaluation frameworks exist, from my review of the literature, there are no recommended frameworks to address this specific topic. It may be useful to conduct a scoping review or environmental scan of evaluations used in relevant studies and explore the utility, legitimacy, and overall impact of a variety of

evaluation frameworks. It may also be useful to conduct a project and outcomes evaluation using several different evaluation tools and techniques and compare the results to discern appropriate strategies. Leveraging the wealth of evaluation work available while focusing on innovative projects in the healthcare and academic spaces would be a valuable addition to this topic area.

Relationships and Networks

A closer examination of the roles, relationships, teams, and networks that function within the complex academic and healthcare spaces and the impact of these people and relationships on innovative project dynamics is another avenue for consideration. Potential areas of focus may include a qualitative exploration of the skills necessary to facilitate innovative project implementation, an evaluation of learning strategies and linking the strategies to adoption and satisfaction metrics, and a network analysis of how individuals and teams in institutions influence innovative project pathways.

Conclusion

In this qualitative case study, I presented an exploration of adoption of innovation in a hybrid healthcare and academic environment. In a context that is complex, unpredictable, and always evolving, it is useful to understand the ways in which individuals, teams, and organizations intersect along the pathway to successful project implementation. While challenges are often highlighted in these explorations, conditions for success also emerge and provide opportunities to better understand and support future projects in similar contexts.

Processes to support the adoption of innovation have been described as non-linear, dynamic, and context specific. A common word that arises in innovation discussion, and with participants in this study, is the “pipeline” through which innovations, or even data itself, flows through a system. However, it has been said that the conceptualization of a pipeline is a poor

representation of what happens in reality, which is a messy and non-linear process (Walker et al., 2020). Due to the complex nature of the health system and the variety of dynamic factors associated with innovation, adoption, and implementation, there may be no linear pathway or formula for successful implementation.

Strategies for success need to be designed for each situation and adapted on an ongoing basis (Cresswell & Sheikh, 2013). We need to better understand the connection between people and technology, engage and support change processes, and motivate staff and stakeholders to reimagine the work associated with the innovation itself (Kelly & Young, 2017). For individuals, teams, or innovators who continue or plan to work in this space, the importance and quality of the innovation itself should be considered the foundation, with people and relationships at the core of project design, stakeholder engagement, institutional navigation, and learning strategies.

Ultimately, it is a thoughtful and well-designed innovation, best supported by motivated and flexible individuals and teams, who are engaged appropriately and communicated with regularly, that can realize the goals of the project. In healthcare, these goals are often based in efficiencies and improvements that lead to better patient care and outcomes, a shared vision for most within these professions, and therefore a challenge worthy of such persistence and hard work. As technological innovations in healthcare continue to evolve, teams can benefit from existing knowledge in parallel spaces and embrace opportunities to document, share, and evaluate future projects.

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Appendix A

Interview Guide

1. Tell me about the earliest time that you can recall working in connection with the [REDACTED] project. What can you recall about the initial conversations or the ‘ask’ of you related to your role / department?

Prompts: How was the information shared? Who approached you and what do you recall about your initial reaction or interpretation of the project that was being undertaken?

 - a. What was communicated to you about the overall goal or intended outcome of the project? As it related to patient care and outcomes?

2. How were you involved with the registry project over time? What role or tasks did you take on?
 - a. Follow-up: Did your involvement change over time?
 - b. What is the current status of your involvement with the registry?

3. Were there new technologies, ideas, or innovations to learn about as you became involved with this project? What were they?

4. How would you describe the level of success you feel related to your involvement with the registry project?
 - a. What factors or influences would you say were instrumental in your response? What key features do you feel might have changed the experience (What would have made it better / worse)?

5. How would you describe the importance of the technical elements in the planning, development, and implementation of the registry project? Where technical refers to the technological innovation of the project.
 - a. What factors did you consider? Is there anything that might have changed your perspective had it been done differently?

6. How would you describe the strategic elements in the planning, development, and implementation of the registry? Where strategy refers to the design and plan of action of the project itself.
 - a. What factors did you consider in your response? Is there anything that might have changed your experience had it been done differently?

7. How would you describe the importance of the political elements in the planning, development, and implementation of the registry project? Where political elements refers to

the activities within or across organizations and encompasses factors such as power, status, will, and position.

- a. What factors did you consider in your answer? Is there anything that might have changed your experience or perspective had it been done differently?
8. If we assume that the registry project was a success, are there other critical elements aside from those related to technology, strategy, and politics, that you feel were instrumental in the development and implementation of this work?
 9. Are there factors or elements of the registry project that, if removed, would have altered the level of success or changed the outcome?
 10. Let's shift now to talk about users of the registry. What level of involvement did you have in how to support change and adoption for downstream users of the registry? Were you involved in any planning or implementation related to building capacity in users to adopt this new innovation?
 - a. What activities took place? What did you observe about the learning that took place as a result of those activities?
 - b. What roles did you observe as part of the learning related to the change event and how did they influence the change process?
 - c. Were there champions? Resisters? Supporters?
 11. Tell me about some of the challenges you recall during your involvement with the registry planning, implementation, or ongoing work. What types of actions were taken in response to those challenges? Looking back, is there anything that could have been done differently?
 12. Tell me about the successes of the project work.
 - a. What kinds of activities supported or ensured these successes?
 13. Were there any notable outcomes of the project as a change event related to your role or your team? What about for the institution / organization you work for?
 14. If you were to sum up your reflections about your experience planning / developing / implementing / maintaining the █████ registry, what would you say that you learned about projects that involve new data-related innovations and supporting adoption and change?
 - a. What aspects of the work would you recommend for future projects? What would you recommend be done differently?
 15. If you were asked to be involved in a similar project in the future, would you want to be involved? Why or why not?

16. Is there anything else you would like to share about that experience that has not yet come up?

Thank you for participating in the interview.

Appendix B

Thematic Map of Findings

Key Themes	Sub-Themes	Categories
People	The Champion	Vision Drive Skills and knowledge *Other champions
	Project team	Contributions Attributes Team dynamic
	Stakeholders	Identifying Engaging Motivations Challenges
	Collaborators	Skills Iterative processes Motivations
Environment	Infrastructure	Policies and processes Siloes System barriers
	Resources	Personnel Technical resources Competing priorities
	Culture	
	Political elements	Power Barriers
	External elements	COVID-19 Government & budget
Innovation	Perception	
	Project design	Data integration Standardization Ethics Evolution of project
	Technology	Technical design Iterations Impact
	Change	The institution The individual Planning change
Learning	Unstructured learning	Learn as you go Collaboration
	Structured learning	Formal / planned sessions
	Know your audience	Base knowledge Common ground User capacity
	Lessons learned	People Strategy