INFORMATICS COMPETENCIES FOR SERVICE INNOVATION IN PARAMEDICINE

THE IMPORTANCE OF HEALTHCARE INFORMATICS COMPETENCIES (HICS) FOR SERVICE INNOVATION IN PARAMEDICINE: A MIXED-METHODS INVESTIGATION

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A Thesis Submitted to the School of Graduate Studies in Partial Fulfillment of the Requirements for the Degree PhD in Business Administration

McMaster University PHD in BUSINESS ADMINISTRATION (2017) Hamilton, ON

TITLE: The Importance of Healthcare Informatics Competencies (HICs) For Service Innovation in Paramedicine: A Mixed-Methods Investigation

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NUMBER OF PAGES: xv, 246

Lay Abstract

Paramedicine in Canada is currently undergoing unprecedented transformation. These changes are driven by the need to relieve emergency healthcare resources from overcrowding, the increase in number of innovative technologies adopted by paramedic services, deployment of paramedics in various non-emergency roles, and increased integration with other healthcare services. The purpose of this dissertation is to determine how paramedic services innovate, and how innovation is influenced by technology. To this end, a two-phase sequential explanatory mixed-methods study is conducted, producing a few key findings that underline the value of technology in paramedicine. First, paramedics with information technology related skillsets can better identify opportunities for improvement in service delivery, and facilitate the organizational adoption of technology. Second, electronic patient care records are a vital source for a variety of innovative activities in paramedic services, such as organization-wide improvement of clinical skills and identification of areas where patient care can be improved.

Abstract

Paramedicine in Canada and throughout the developed world is currently undergoing unprecedented transformation to its service delivery model, largely driven by the need to relieve healthcare systems from overcrowding, and ensure its availability for all citizens. These changes are facilitated by the ability of paramedic services to adopt a number of innovative technologies, and their ability to respond by adopting new service delivery models, which may entail the deployment of paramedics in various non-emergency roles or integration with other healthcare services.

The purpose of this dissertation is to determine how paramedic services innovate, and how that innovation is influenced by technology in particular. To fulfill this purpose, a two-phase sequential explanatory mixed-methods study is conducted, with a quantitative phase followed by a qualitative phase.

In the first phase a multilevel theoretical model consisting of constructs that measure Service Innovation Performance, Dynamic Capabilities, Information Technology (IT) Capabilities and Group-Level Healthcare Informatics Competencies was evaluated with WarpPLS 5.0. A dataset with participation from paramedic leaders of Canadian land-based paramedic services (n=43) and paramedics employed at these services (n=502) was used for this purpose. Findings from this phase indicate that the information technology related knowledge and skills possessed by paramedics have an impact on various organization level dynamic capabilities, as do various IT Capabilities that focus on the relationship between the paramedic service leadership and the IT service provider.

In the second phase, a qualitative approach was taken to explore contextual and other factors that facilitate or inhibit the ability of a paramedic service to innovate. Results from this phase suggest that Canadian paramedic services primarily undertake innovative activities with a strong focus on assuring and improving patient care. The use of an electronic patient care record (ePCR) is an important resource, as it enables activities such as the improvement of the clinical skills of paramedics, as well as facilitates the generation of business cases for equipment investment. Further, the informatics competencies of paramedics greatly facilitate the adoption of technology and equipment by individual services, as paramedics with a high amount of these competencies assist other paramedics when adopting technology, communicate innovative ideas within a service, and identify areas in need of change. The results of this dissertation underline the value of technology-related knowledge and skills for paramedics, and the importance of technology in ensuring that paramedic services provide a high and continually improving standard of patient care.

Acknowledgements

I would like to express my gratitude to Dr. Joseph Tan, my doctoral supervisor, for his invaluable guidance and advice, and generosity throughout this challenging process. I would also like to acknowledge the assistance of Dr. Norm Archer, Dr. Kai Huang and Dr. David Armstrong, my doctoral committee members, for their time, guidance and encouragement.

To the faculty, staff and my friends that helped me during this journey, I thank you. Deb Randall Baldry, Carolyn Colwell, Lorraine Wilson, and Iris Kehler were indispensable when a roadblock was hit, or a new road opened.

To my family and friends that provided me with emotional (and financial) support during the process, your kind words and actions did not go unnoticed. Tim Hardie, your guidance continues to shape who I am as a professional. Marlene Green, the influence of your ideas in this project is a showcase of your intellect. Isaam Dawood, I never knew that I could even do this before you encouraged me. Without the love I get from my mom Kathy, my gramma Mary, my sister Rose, my fantastic wife Sue, my amazing and brave children Luke and Avery, and Logan, this accomplishment has no meaning to me.

If it wasn't for one more person, none of this would have happened. My father, Stephen Dohan. I would have no concept of the value of education, hard work, or knowledge, without raising me the way he did, although it took me getting a PhD to fully realize these lessons. You have given me a base for which to raise my own children, your grandchildren. I love you.

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List of Abbreviations

AARS – Average Adjusted R^2

AB – Alberta

ABVIF – Average Block Variance Inflation Factor

ACP – Advanced Care Paramedic

AED – Automated External Defibrillators

AFCVIF – Average Full Collinearity Variance Inflation Factor

AGO – Auditor General of Ontario

AHS – Alberta Health Services

ANA – American Nurses Association

ANOVA – Analysis of Variance

APC – Average Path Coefficient

ARS – Average R^2

AVE – Average Variance Extracted

CCP – Critical Care Paramedic

CFA – Confirmatory Factor Analysis

CITIG – Canadian Interoperability Technology Interest Group

CP – Community Paramedicine

CPR – Cardiopulmonary Resuscitation

CR – Composite Reliability

CREMS – Community Referrals by Emergency Medical Services

CTAS – Canadian Triage and Acuity Scale

DC – Dynamic Capability

eACR – Electronic Ambulance Care Report

ED – Emergency Department

EFA – Exploratory Factor Analysis

EHR – Electronic Health Record

EMR – Electronic Medical Record

EMS – Emergency Medical Services

EMSCC – Emergency Medical Services Chiefs of Canada

ePCR – Electronic Patient Care Report

ePHR – Electronic Personal Health Record

EMProj – Effective Management of Information Technology Projects

EUInfo – Effective Use of Information

EUTech – Effective Use of Information Technology

GoF – Goodness of Fit

HALO – High Acuity, Low Opportunity

HCR – Human Capital Resources

HIC – Healthcare Informatics Competency

HL7 – Standards Development Organization Health Level 7

ICC – Intraclass Correlation

ICP – Intermediate Care Paramedic

ICT – Information and Communication Technologies

IPC – Information Processing Competencies

IT – Information Technology

JCREC – Joint Committee on Rural Emergency Care

KBV – Knowledge Based View

KMO – Kaiser-Meyer-Olkin

KSAOs – Knowledge, Skills and Other Attributes

MB – Manitoba

MOHLTC – Ontario Ministry of Health and Long-Term Care

N/a – Not applicable

NEMSIS – National EMS Information System

NG-911 – Next Generation 911

NHS – National Health Service

NHTSA – National Highway Traffic Safety Administration

NIC – Nursing Informatics Competencies

NL – Newfoundland and Labrador

NOCP – National Occupational Competency Profile for Paramedics

NREMT – National Registry of Emergency Medical Technicians

OAPC – Ontario Association of Paramedic Chiefs

ON – Ontario

PCP – Primary Care Paramedic

PCP+ - Primary Care Paramedic with additional training

PCR – Patient Care Record

PLS – Partial Least Squares

r(wg) – within-group agreement

RBV – Resource Based View

REB – Research Ethics Board

RHA – Regional Health Authority

RN – Registered Nurse

RQ – Research Question

SEM – Structural Equation Modelling

SEMSA – Saskatchewan Emergency Medical Services Association

SIP – Service Innovation Performance

SK – Saskatchewan

STEMI – Segment Elevation Myocardial Infarction

T – Territory (blinded)

TAC – Technology Application Competencies

TIGER – Technology Informatics Guiding Educational Reform

TOC – Transfer of Care

UWT – Understanding of the Workings of Technology

VIF – Variance Inflation Factor

WHO – World Health Organization

Declaration of Academic Achievement

My Ph.D. supervisor, Professor Joseph Tan, and I designed the research conducted in this dissertation. Although I have chosen to use the term “the researcher” where applicable throughout the dissertation manuscript and presentation, I recognize these contributions by my supervisor. Nonetheless, this dissertation represents original research that I conducted, as follows. With the advice and guidance of Professor Tan, I conducted thematic review of extant literature, developed the theoretical foundations for the hypotheses, and prepared the ethics approval application for the empirical research protocols, which was subsequently approved. Under Professor Tan’s supervision, I designed and conducted the quantitative and qualitative data collection and performed all quantitative and qualitative analyses. I wrote the dissertation manuscript with the editorial advice and supervision of Professor Tan. Earlier drafts of a part of this research was presented at several academic conferences as part of the research development process.

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Chapter 1: Introduction

Paramedicine in Canada and throughout the developed world is currently undergoing unprecedented transformation to its service delivery model, largely driven by the need to relieve healthcare systems from overcrowding, and ensure its availability for all citizens. These changes are largely driven by the increase in number of innovative technologies adopted by Emergency Medical Services (EMS), deployment of paramedics in various non-emergency roles, and increased integration with other healthcare services. Despite this dire need to preserve the integrity of one of society's most important healthcare resources, the amount of scholarly activity that is valuable for innovation in paramedicine, the use of technology in paramedicine, or other similar topics is low.

The purpose of this dissertation is to determine how paramedic services innovate, and how that innovation is influenced by technology in particular. This first chapter provides an introduction and overview to the topic, its importance, and the approach used herein. First, a background of paramedicine in Canada will be given, in the context of the problems and changes that are currently taking place, as well as the implications for paramedic services in Canada in particular. Second, research gaps will be articulated, and research questions that support the purpose of this dissertation and will be presented. Finally, an overview of the approach that will be used on this dissertation will be provided, including the worldview of the researcher, theoretical and methodological approach, and structure of the dissertation.

1.1 Background - Emerging Changes in Paramedicine

Canadian paramedics provide an essential service to Canadians when urgent medical care is needed. Alberta Health Services (AHS) responds to 400,000 events per year, an average of about 1095 per day for a province with a population of over 4.1 million (Alberta Health Services (AHS), n.d.). In comparison, Ontario, a province with a population of 13.6 million, saw 900,000 transports in 2012 (Ontario Ministry of Health and Long-Term Care (MOHLTC), 2012). Despite the importance of this essential service to public safety in Canada, there are several problem areas limiting the reliability of this service. These limitations often manifest in the unavailability of limited emergency healthcare resources, and negative impacts on the health and well-being of both citizens and front-line paramedics. Some of these problems are detailed below.

1.1.1 Problems in Emergency Healthcare

Many problems affecting paramedic services manifest as a lack of availability of ambulances. When availability is severely limited, a situation may occur where there is one or fewer ambulances available to respond to emerging calls. These are referred to as code zero events (Browett, 2010). As an example, the city of Hamilton, Ontario, with a population of over 500,000 has experienced 82 code zero events in 2009, down from 95 from 2008 (Browett, 2010). This problem is also documented elsewhere (Yourex-West, 2015; Desmond, 2016). This unavailability of paramedics can be attributed to a number of causes, including inaccurate dispatch protocols, unnecessary transports, ED

(Emergency Department) overcrowding, and long wait times to offload patients to ED teams.

Many of the problems that impact paramedic services begin at dispatch, where an operator will receive a 911 call, and direct a service to respond and deploy paramedics. Part of this dispatch will involve gathering information about the call, as well as assigning the call a priority, which will then in turn direct the level of response of paramedics. Calls that are under-prioritized (i.e. a "prompt" response when an "urgent" response is needed[1], or a Type I error) could mean that a patient experiences a delay in care when it is desperately needed. On the other hand, over-prioritized calls (i.e. an "urgent" response when only a "prompt" one is truly sufficient, or a Type II error) are also a source of several known problems (Auditor General of Ontario (AGO), 2013). First, if paramedics are dispatched at an "urgent" priority for a minor problem, the paramedics cannot be diverted to any additional urgent problems that emerge. Second, as paramedics may respond with lights and sirens, high speed, and otherwise lawfully speed or proceed against red lights, both paramedics and public are put at risk on public highways (Singh et al., 2010), often to no significant benefit with respect to patient outcome (Isenberg et al., 2012; Brown et al., 2000). As well, if there are an excessively high number of over-prioritized calls, paramedics may experience "alert fatigue" (Sofianopoulos et al., 2012), where paramedics begin to ignore the priority assigned by the dispatcher.

[1] As dispatch priority codes differ across jurisdictions, these generic terms are used.

The transport of patients may occur, even when transport would normally be deemed medically unnecessary (Camasso-Richardson et al., 1997; Brown & Sindelar, 1993; Billittier et al., 1996). Unnecessary medical transport may occur for several reasons. Lack of other means of transport is commonly cited as a reason (Billittier et al., 1996; Camasso-Richardson et al., 1997). Also contributing to the number of unnecessary transports are patients who can be identified as frequent users of paramedic and other emergency services (Norman et al., 2016). As well, many of these unnecessary visits to EDs involve the elderly (Aminzadeh & Dalziel, 2002) and those suffering from chronic diseases (Bureau, 2010; StatsCan, 2010). As patients of both of these types can be more complex due to factors such as lack of mobility and cognitive function, recurrence of symptoms and exacerbations, comorbidities, and lack of social support, an episodic approach to care for these patients is seen as inappropriate and wasteful (Ontario Ministry of Health and Long-Term Care (MOHLTC), 2007)

ED overcrowding occurs when the number of patients visiting an ED is greater than its normal capacity, and is an issue in Canada and elsewhere (Elder et al., 2015; Drummond, 2002; Moskop et al., 2009). This can result in neglected patients whose further health problems or deaths can be attributed to overcrowding (Richardson, 2006; Sprivulis et al., 2006). For the paramedic, arrival at an overcrowded ED could mean delay in patient offload, which refers to the period of time that elapses between the arrival of paramedics and patient at the ED, and the Transfer of Care (TOC) between the paramedic and the ED. If there happens to be congestion at the ED, then there may be a delay in

TOC (Cone et al., 2012), thereby preventing the paramedics from returning to duty. In addition, the information exchange that the paramedics and ED staff engage in is important, as many details regarding the patient's condition are exchanged (Benner et al., 2008). This process can be complicated by the exchange of data during this time, especially if there are paper printouts or non-integrated information systems between the ED and the paramedic service involved (Feufel et al., 2011).

1.1.2 Addressing the Challenges in Emergency Care

In order to address these problems, there are two general strategies that paramedic services can undertake in order to reduce the performance dimensions that are important for the healthcare system. Both of these activities are directed at improving paramedic practice, operational and healthcare system level outcomes, as well as clinical and satisfaction outcomes of the patients that they serve. First, paramedic services can undergo changes to their *service delivery models*, or they can adopt *innovative technology*. Both of these strategies are not mutually exclusive (i.e. changes in a service

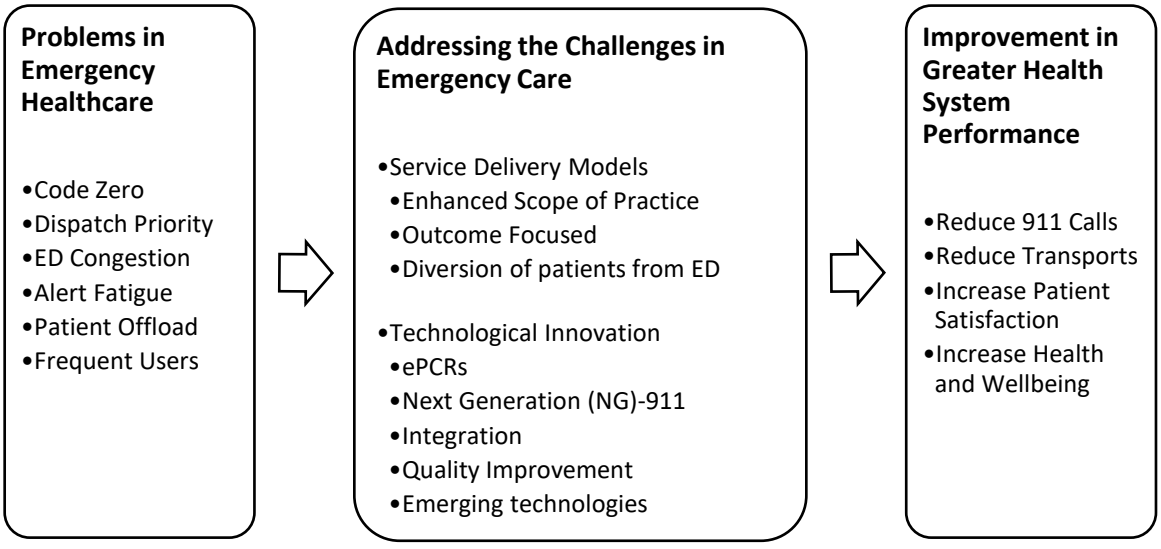

Figure 1.1: Addressing Challenges in Pre-Hospital Care.

delivery model may imply adoption of technology, and vice versa), and described in more detail separately below. Figure 1.1 (above) depicts how these strategies that paramedic services can undergo would fit with improvement in the healthcare system as a whole.

1.1.3 Addressing Challenges Through New Service Delivery Models

A service delivery model comprises the policies, processes and other similar resources needed to provide a service. Traditionally, the paramedic service model entails *responding* to emergency calls, administering *treatment* to patients on scene as needed, and if needed, *transporting* them to EDs for further treatment (Dick, 2003). Community Paramedicine (CP) is a loosely defined term that describes a new approach in prehospital care. Governments such as the Province of Ontario (Ontario Ministry of Health and Long-Term Care (MOHLTC), 2014) and Manitoba (Government of Manitoba, 2013), as well as the National Health Service (NHS) in the United Kingdom (NHS North West Ambulance Service, 2015) are funding CP projects that are undertaken by paramedics and paramedic services, but otherwise do not fall under this rigid traditional model of paramedicine.

Currently, there is a lack of consensus as to what a community paramedic is, what CP entails, or what a CP service delivery model entails, as many different jurisdictions are adapting the model to their own local context (Blacker et al., 2009; Cooper & Grant, 2009). Further, there are several different terms to describe what appears to be the same role, such as extended care paramedic (Novascotia.ca, 2012), paramedic practitioner (Mason et al., 2003) and others. There are however four dominant themes that can be extracted from current writings: these programs are intended to *reduce healthcare*

utilization; an *expanded scope of practice* for paramedics; programs that are *adapted to local conditions;* and these programs *often involve non-emergency deployment of paramedics.*

- **Healthcare Utilization Reduction:** The intention of these programs is to provide care in such a way that it will eliminate the future need for emergency healthcare access in identified and targeted populations (TravisCountyHD.org, n.d.; Joint Committee on Rural Emergency Care (JCREC), 2010; EMSCC, 2011). Some studies have reported success in such initiatives, citing lower cost and higher satisfaction (Martin-Misener et al., 2009), reduced ED utilization (2007) and reduced emergency call volume (2006). Diversion of patients away from emergency services and towards lower resource healthcare providers such as home care and other social services can avoid future paramedic calls and transports to the ED (Byrne et al., 2003; Doupe et al., 2008; Mitchell, 1994). Remote area clinics staffed by paramedics were designed to eliminate lengthy medical travel (Novascotia.ca, 2012). The ability of paramedics to create referrals to clinics or social services when responding to a call eliminated the need for a transport and ED visit, as well as connecting a patient to receive an appropriate level of care (Browett, 2011)
- **Expanded Scope of Practice:** In these programs, paramedics in all areas experience change to their scope of practice, by adding skills beyond the current scope. In a program in Renfrew, Ontario (O'Meara et al., 2014), the skillsets these paramedics identified as important and differing from the ones they already possessed were the

ability to communicate with the patient before applying medical knowledge to their care, building trust and long term relationships. Challenges that the paramedics faced when performing in a CP role were having the skills to create long term relationships, education around determinants of health, and training in the soft skills involved in conducting CP. Community paramedics in Australia (2007) identified communication with other healthcare workers and working with technology as major issues.

- **Local Adaptation:** As each community is unique, so also will be the problems that CP implementations will address. The paramedic service in Toronto – a city with a large number of skyscrapers and condominiums - offers a CP initiative to address falls from balconies and windows (Toronto, 2010). Australian CP programs attempt to address needs respective to each region, with unique certification and training schemes (Blacker et al., 2009). The largely rural County of Renfrew, Ontario, Canada offers care focused on aging at home, conducting wellness clinics, and home visits (Blacker et al., 2009; Cooper & Grant, 2009). In order to address a doctor shortage and high patient transport cost in an island-based community, a clinic was created that is staffed by community paramedics and used for checkups, minor wound care and prescriptions, and other issues (Picard, 2014). Many communities in Ontario cities such as Toronto offer Community Referrals by Emergency Medical Services (CREMS; Browett, 2011; Olynyk et al., 2010). This program involves close collaboration with other community healthcare providers, to allow for paramedic services – often the first point of contact for many patients that don't regularly access

healthcare – to refer patients directly to a variety of healthcare services, as opposed to an ED.

- **Non-Emergency Deployment of Paramedics**: Often, CP programs involve the deployment of paramedics in ways that are not congruent with the traditional "respond-treat-transport" model. This may involve deploying paramedics to home care appointments, holding clinic sessions at strategic locations such as remote communities (Novascotia.ca, 2012) or nursing homes (Moulton, 2011). There are exceptions to this approach, as CP may involve something as simple as providing referral for an appointment in lieu of a hospital transport (Olynyk et al., 2010).

Although early evidence for many of the diverse number of programs underneath the CP banner indicates that this approach can be impactful, these changes present several problems for paramedic services. First, such changes will compel paramedics to expand their use of technology (EMSCC, 2006), such as Electronic Medical Records (EMRs), Electronic Health Records (EHRs), Electronic Personal Health Records (ePHRs), or a myriad of paramedic-focused devices and smart phone apps. This presents challenges to Paramedic Leaders and technology designers in ensuring that these technologies are used effectively (DeLone & McLean, 2003; Petter et al., 2008; Venkatesh et al., 2003; Davis et al., 1989). Further, as incremental change is seen as the way to achieve high quality in the long run (Tan et al., 2005; de Koning et al., 2006), there will be a need to shape the services and programs implemented by paramedic services to reflect the local environment that the CPs practice in, as well as to ensure that these changes have a

positive impact on performance. This implies that these services, at the organizational level, must be responsive to local conditions, guided by a different set of meaningful performance metrics, and involve collaboration with other healthcare providers, among other concerns.

1.1.4 Addressing Challenges Through Technological Innovation

Many technological developments and change are impacting paramedics, largely affecting diverse areas of their job where clinical and operational improvements are made. A 2014 report (Canadian Interoperability Technology Interest Group (CITIG), 2016) identified many disparate technologies that Canadian Paramedic Leaders desire to see as part of normal practice. Key among these is a next-generation 911 system (NG-911), which would feature enhanced data transmission capabilities, partly enabled by the introduction of the 700 MHz Broadband for wireless transmission of mission critical public safety data. Other topics mentioned in the report that would impact paramedics are integration of technology with care, in-ambulance mapping, in-ambulance use of tablets for routine data entry, feedback tools for cardiopulmonary resuscitation (CPR), use of social media to engage community, and others.

One technology that is becoming central to paramedicine practice and impacts many areas is the electronic patient care report (ePCR; sometimes referred to as electronic ambulance care report, or eACR; Cohen, 2013). This technology tracks the standard details regarding a paramedic's encounter with a patient, including details given at dispatch, clinical and demographic data, as well as outcomes of the encounter. Typically,

a record is created in the ePCR after each call, and paramedics are often supplied with laptops in their ambulances to enter the data. The resulting datasets from the ePCRs are essential for any clinical or operations quality improvement initiatives and practice audits (Cohen, 2013). These ePCRs can also be integrated with hospital EMRs to evaluate hospital outcomes from pre-hospital care (Newgard, 2011).

ePCRs periodically undergo change to adhere to new standards and innovations. In the United States, the National EMS Information System (NEMSIS; http://nemsis.org/) is a national database that is used to drive performance and benchmarking activities in EMS, with over 90% of American paramedic services reporting into this database. A variety of about 30 ePCR applications are "gold standard compliant" with the current version of the NEMSIS. NEMSIS itself is undergoing transitions to be compliant to the Standards Development Organization Health Level 7 (HL7) standard for electronic health information exchange that supports various clinical and managerial processes in healthcare (http://hl7.org). In Canada, no such database is known to exist. A Canadian version of NEMSIS would have immense benefit for purposes of studying EMS performance on a national scale, but a large degree of change for many paramedics and paramedic services is needed for this to happen.

Integrating ePCRs with the hospitals they transport to could potentially improve offload times and communication (Schooley et al., 2010). Effective information exchange during patient offload can also impact patient safety (WHO Collaborating Centre for Patient Safety Solutions, 2007). During patient offload, ambiguities can arise from poor

communication protocols or interdisciplinary differences, resulting in potential inappropriate care or other harm to the patient. Integrating ePCRs with hospital electronic records is one option that can be used to facilitate this process.

Early notification has potential in improving clinical and operational outcomes for stroke (eg. Khor et al., 2015; O'Brien, 2012) and cardiac patients (eg. Kobayashi et al., 2016; Stowens et al., 2015), two important clinical issues where paramedicine makes a difference (Heart and Stroke Foundation, 2015; Cardiac Care Network, 2013). Early notification, which refers to notifications sent to the ED prior to arrival, potentially along with clinical and other data, can alert various hospital departments to prepare for an incoming patient, and could come in many different technological forms, including voice-only lapel microphones (Stowens et al., 2015) and transmission of clinical data (Adams et al., 2006).

Another area of emerging technological innovation involving paramedics would enhance paramedic-physician collaboration. Potentially, paramedics could access physicians real-time on site to collaborate on diagnoses, obtain legal permission to perform a procedure, or other similar queries. Several technologies are being developed to facilitate this level of collaboration. A 3D telepresence model has been developed that would allow for this real-time collaboration (Welch et al., 2009). Although paramedics were encouraged with this technology, they believe that more training is needed to use it, and some inter-professional issues must be addressed. A system that allows for paramedics and cardiologists to collaborate by exchanging telephone messages and

electrocardiograph data at the same time showed in a small scale study that this is capable of reducing time to angioplasty (Strauss et al., 2007).

Besides impacting these main areas of paramedic practice, a wide array of devices and technologies can extend paramedic capabilities. Options exist for drone use in paramedicine, including the delivery of medication and defibrillators, allowing for remote voice communication, monitoring areas, and other applications (Katz, 2015). Advancements in automated external defibrillators (AEDs), including those in public places, allow for electrocardiogram data to be recorded, and downloaded onto an ePCR (Hansen et al., 2014). This data can then be used for providing feedback to paramedics regarding their CPR skills (Yeung et al., 2009). Many smart phone apps are available to assist paramedics on the job, such as medication databases, AED locators, and simple information sharing with EDs (EMS1.com, 2014). EMS1 (http://ems1.com) is a website that features articles for informing paramedics on a wide variety of topics, including emerging technologies for paramedics. As well, the site features content for online learning and a forum that facilitates community and knowledge exchange among paramedics. Voice-enabled ePCRs (Mazza et al., 2006) may have the benefit of hands-off use and capture of dictation by the paramedic, but still imply more training for paramedics.

1.2 Gaps in Research

Given the challenges that are affecting paramedic services in Canada, as well as the opportunities that paramedic services have with adopting new service delivery models

and technologies, there are still several gaps in research to be explored. The first gap identified pertains to the paramedics, who most affected by changes in the currently accepted model of paramedicine. There are many models that have been used to study various concepts related to the use of technology by a variety of healthcare professionals in the healthcare context, both for clinical and non-clinical purposes (Timmons, 2003; Hu et al., 1999; Liang & Wu, 2010). Paramedics have infrequently been the subject of these topics (eg. Weiss et al., 2005). Although concepts that capture attitudes such as perceived ease of use and perceived usefulness (Davis, 1989; Venkatesh & Davis, 2000), user satisfaction and information systems success (Wixom & Todd, 2005; DeLone & McLean, 2003) and technology self-efficacy (Compeau & Higgins, 1995) have contributed much to the field of information systems, there is a shortcoming with these concepts in a context that is heavily characterized by change. This shortcoming is that none of these concepts *capture the knowledge and skills needed by these healthcare professionals to facilitate innovation and change*. These skills and knowledge may entail much more than just the appraisal of a single technology, or the confidence that one can use technology. Informatics competency models, which capture the required knowledge and skills that healthcare professionals need to use technology in their respective roles (O'Carroll, 2002; Hart, 2008), are constructed in order to cover the spectrum of skills needed to use technology in a given role, but no known model exists for paramedics.

Second, there is a lack of literature that addresses *innovative change in paramedicine* from the perspective of the healthcare organization. Although many

benefits can result from change and technological innovation in healthcare (Eysenbach, 2001), it is difficult to introduce change due its complexity, potential dire results for mistakes, and other factors. Various organizational models for guiding quality improvement have been applied in healthcare contexts (Berwick, 2003; Sittig & Singh, 2010; eg. Antony et al., 2012; Singh et al., 2011). However, there seems to be a lack of research that has applied any of these models in the paramedicine context, in terms of the changes that are currently affecting paramedic services in the developed world. Furthermore, there has been calls to research how assorted capabilities associated with using technology on the organizational ability to change.

1.3 Research Questions and Rationale

As previously stated, the purpose of this dissertation is to determine how paramedic services innovate, and how that innovation is influenced by technology in particular. The following research questions will guide this dissertation:

> *RQ1: Do the organizational abilities to reconfigure and integrate with other community partners influence the ability of the paramedic service to innovate?*
>
> *RQ2: Do IT Service Provider related capabilities influence a paramedic service's ability to innovate?*
>
> *RQ3: Do the technology-related knowledge and skills possessed by paramedics influence the ability of their respective services to innovate?*

The first three research questions, to be addressed in the quantitative first phase of the study, will capture the degree to which paramedic services rely on integration with

other services, the sharing of knowledge between Paramedic Leaders and IT providers, and the knowledge and skills of paramedics, in order to successfully innovate.

> *RQ4: What factors are associated with paramedic services' ability to innovate?*

This broad research question will be addressed in the qualitative phase 2 of the study. In particular, this question takes a broader perspective on innovation within paramedicine, and its purpose is to discover important factors, contextual and otherwise, that facilitate or inhibit innovation in paramedic services. A broad perspective is necessary to capture a variety of factors, including organizational processes, governing bodies, community and geographical nuances, and other factors that have not been previously theorized.

> *RQ5: How do the quantitative and qualitative data together reveal approaches to improving the ability of a paramedic service to innovate?*

This research question is to be addressed in phase 3 of the study. In mixed methods studies such as this one, there is a phase where the results of the two previous phases are mixed, in order to discover knowledge that could not be discovered from analyzing each of the previous phases in isolation (Creswell & Plano Clark, 2011). The outcome of this research question will be several propositions which can be used to guide future research and the refinement of the theoretical model presented herein.

1.4 Theoretical Approach

Two main theoretical approaches, pertaining to the use of technology and organizational change respectively, can assist in the accumulation of knowledge valuable

for this purpose. First, the Dynamic Capabilities (DC) approach focuses on the capabilities of the organization to reconfigure resources to address changing forces in the environment, and their contribution to performance (Teece, 2007; Teece et al., 1997). Second, the Competencies approach (White, 1959; Mirabile, 1997; McClelland, 1973) entails evaluation of employees based on skills and knowledge needed to occupy a defined role. This approach has been applied to informatics in healthcare, referred to as Healthcare Informatics Competencies (HICs), most notably for nursing (eg. Hunter, McGonigle, & Hebda, 2013) and public health (eg. Yasnoff, O'Carroll, Koo, Linkins, & Kilbourne, 2000). Although there is some potential in this stream of research in studying the adoption of healthcare technology use, there is a lack of evaluation of the impact of competencies against both individual and organizational performance outcomes. Other supplementary theories, including the Resource Based View (RBV) of the firm is used to explain the importance of several relevant capabilities associated with ensuring the effective use of technology in the firm (Kim et al., 2011; Wernerfelt, 1984).

1.5 Methodological Approach

This project employs a mixed-method approach, specifically, a sequential explanatory mixed methods research approach (Creswell & Plano Clark, 2011; Creswell, 2009). This approach is characterized by a quantitative phase, with a supplementary follow-up qualitative phase. The quantitative phase will see the testing of hypotheses within a theoretical model that integrates HICs and DCs. The theoretical model in this phase will be a multilevel theoretical model (Snijders & Bosker, 1999; Reise & Duan,

1999), which is used when phenomena at an individual level is theorized to impact phenomena at a group (i.e. organizational) level. In this case, paramedics are considered as individual level respondents, which will be grouped by their respective paramedic services. The follow up qualitative phase will explore themes and present discovered insights related to the inhibition or facilitation of service innovation within healthcare organizations. This phase will utilize in-depth interviews with select Paramedic Leaders from the first phase to explore their context with respect to their abilities to innovate.

The sequential explanatory mixed methods methodology is used here because a greater understanding of a problem is sought, beyond the degree that a quantitative phase on its own can provide (Creswell & Plano Clark, 2011). Also, this approach is used because it is convenient to collect supplementary qualitative data that can be used to shape new research questions (Creswell & Plano Clark, 2011). As this is a low-resource study, this phase is used to merely embellish the findings from the first phase, and is supplementary in that respect. Indeed, to gain a deeper understanding of the context of interest would likely involve a qualitative phase that required more resources, or a separate qualitative study altogether. In this case, it is appropriate to maintain a loose underpinning between the two phases (Mason, 2006).

1.6 Worldview

It is important for researchers to articulate their worldview, as it communicates the assumptions and beliefs about the nature of knowledge and how that informs their study, data collection and analysis techniques, and even how results are communicated (Guba &

Lincoln, 2005). The theoretical perspective that this researcher subscribes to is the pragmatic perspective. This differs from a purely post-positivist worldview where knowledge is discovered through quantitative methods and a cause-and-effect perspective (Phillips & Barbules, 2000). Also, this differs from an exclusively constructivist worldview where participants and their subjective views and histories can be accessed to discover phenomena (Crotty, 1998). The pragmatic view believes that both post-positivist and constructivist worldviews are valid, and that no one worldview is isolated from another when it comes to research (Crotty, 1998). A multitude of these worldviews can be used to access reality, and can subscribe to a mixture of perspectives within a research project.

Within this project, various scientific methods are used. The *deductive* method, which is related to the post-positivist perspective (Phillips & Barbules, 2000), originates in the natural sciences. Phenomena are detected through the observation of one phenomenon predicting another, verified through the empirical and quantitative validation of a hypothesis. The *inductive* method, which is linked to the constructivist perspective, involves detecting phenomena by inferring from observation and rich description (Crotty, 1998). These two approaches are commonly viewed as the two main approaches to generating knowledge in the scientific method, and both are used in mixed methods studies. However, this research will also employ *abductive* means of generating knowledge. This lesser known approach, often but not exclusively used as part of the grounded theory approach (Suddaby, 2006), entails the detection of phenomena for the

purpose of generating plausible theory (Haig, 2005a). This often involves some type of quantitative data analysis, visualization or organization to discover patterns in a dataset to inform the development of theory (Haig, 2005b; Tukey, 1977; Behrens et al., 2003).

1.7 Contributions

This research makes the following contributions. First, this research is a demonstration of new possibilities for HIC research. Although HIC research is widespread in healthcare, it currently focuses on developing competency models, which are essentially lists of competency items, generated for specific roles in healthcare. Research where HICs are included in hypotheses as either dependent or independent variables is rare, yet provides a large potential to justify the development of these skills in healthcare organizations through their ongoing research. Second, this research will attempt to provide empirical evidence establishing HICs as contributors of DCs. As HICs can be considered a measurement of knowledge and skills, this research contributes to the growing number of publications that answer this call to research the impact that individual knowledge, skills, and other attributes have on organizational processes and performance (Felin et al., 2009). Finally, the DC approach, although applied widely in other areas, has not been applied widely in the healthcare context.

1.8 Dissertation Structure

This dissertation has the following structure. This (first) chapter outlines the background of paramedicine in Canada and the developed world, the changes it is currently undergoing, the research questions, rationale for this research, and other initial

details. Chapter 2 presents a literature review of previous applicable research and theories relevant to addressing the gaps in research that were previously articulated. Chapter 3 outlines the theoretical model to be used in this research. A multilevel model, with paramedics being nested within their respective services, is presented. Chapter 4 outlines the sequential explanatory mixed methods methodology used in this research, and presents details as to how both the theoretical model is evaluated in the first quantitative phase, and how interview data are evaluated in the second qualitative phase. Chapters 5 and 6 present the results from both the quantitative and qualitative phases, respectively. Chapter 7 attempts to stimulate further research on the topics of technology and innovation in paramedicine by showcasing the resulting insights from this research, as well as presenting several propositions that can direct future research in the area.

Chapter 2: Literature Review

As previously articulated, the purpose of this dissertation is to determine how paramedic services innovate, and how that innovation is influenced by technology in particular. Pressures in the healthcare system are currently compelling paramedic services to adopt new technology and service delivery models. Therefore, research in this area must inform Paramedic Leaders on how to approach innovation and adoption of technology, as well as stimulate more research in these areas. To support this purpose, this chapter will present a literature review that will help inform the development of a novel theoretical model, which in turn aims to address the two gaps in research that were previously articulated.

Due to the noted lack of literature relevant to innovation models in healthcare and paramedicine, as well as a lack of literature that explains the relationship between informatics competencies and organizational ability to innovate, a systematic approach to the literature review would not have been fruitful. Therefore a non-systematic, or narrative, approach was used for this review. Although systematic reviews arguably result in a more complete review of the literature on a defined topic, narrative reviews can be more effective at synthesizing a more diverse body of knowledge, or developing a theoretical model through the integration of theories from different areas (Green et al., 2006). To strengthen the literature review, two field experts were consulted to assess the applicability of the literature reviewed.

This chapter first provides an overview of the theoretical perspectives of this research, and rationale as to the relevancy of these theories to this problem. This will be followed by an in-depth review of HICs and DCs, the two main theoretical perspectives used in this research, as well as some supplementary theories that this research will draw on. Finally, as these theories have never been integrated before, justification for the integration of these two theories will be presented, followed by some summarizing remarks for this chapter.

2.1 Theoretical Perspectives for this Research

This research will utilize an integrated approach informed by two main theoretical perspectives, chosen specifically to address the aforementioned research gaps (See Section 1.2 (Gaps in Research), above). The first perspective will assist in addressing the first research gap identified here, pertaining to the lack of research that demonstrates the contribution of the knowledge and skills paramedics in facilitating innovation and change. Healthcare Informatics Competencies (Staggers et al., 2002; White, 1959; HICs; McClelland, 1973), refers to the skills and knowledge necessary for occupants of healthcare roles to be proficient at using technology and information systems on the job. The use of competencies is appropriate, as it offers a robust conceptualization of the skills and knowledge that a worker needs to effectively use information systems and technology on the job, an approach that is widely used in healthcare.

The second theoretical approach was chosen to address the second research gap, which pertains to the lack of research on how innovative change occurs in paramedicine.

Dynamic Capabilities (Teece et al., 1997; DCs; Eisenhardt & Martin, 2000; Teece, 2007), is an extension of the RBV of the firm (Wernerfelt, 1984; Tarafdar & Gordon, 2007). This refers to the ability of a firm to reallocate its resources to match changes in its environment for maintaining superior business performance in the long-term. As a supplement, several IT Capabilities will be integrated as well, which refer to the effectiveness at which an organization can employ the technological resources under its control (Grant, 1991; Grant, 1995; Bharadwaj, 2000; Ha & Jeong, 2010; Piccoli & Ives, 2005). IT capabilities are included here, as they have been shown to influence DCs (Kim et al., 2011).

2.2 Healthcare Informatics Competencies

The concept of competence originated from the notion that an organism needs a certain level of capacity to interact with its environment, obtained through a period of doing and learning (White, 1959). The concept is concerned with natural human motivation to explore novelties within their environments (White, 1959). The concept has been applied in the management area to refer to the ability of a worker to perform according to role requirements (McClelland, 1973). Researchers and practitioners were then able to develop competency models on which to test the individual occupants of these roles, as well as predict actual performance, as an alternative to using non-contextual and poorly performing intelligence scales for the same purposes (Mirabile, 1997). The format and structure of competency models vary widely, although they commonly consist of a defined list of success factors for each role, descriptions of the

behavior necessary to achieve success, and a rating scale to compare competency levels against a level of proficiency. Other formats include a cluster-type format, where competency items are grouped by theme. Competency models of these types can then be administered to the occupants of each role as a self-reported instrument, or one that is used by an observer (Mirabile, 1997).

Healthcare has adopted the competency approach, applying it to educators (Srinivasan et al., 2011), administrators (Lin et al., 2012), physicians (Jefferies et al., 2011), and many other specialized roles, as well as in the areas of pharmacy (Fuji & Galt, 2015) and nutrition (Maunder et al., 2015). It is seen as an essential component for the implementation of an evidence based practice (Bakken, 2001), along with standardized terminology, digital sources of evidence, data exchange standards, and processes to integrate these sources of evidence with the various people involved in healthcare. Researchers have focused on developing competency models for the use of technology in various roles in healthcare. These models, referred to as Healthcare Informatics Competencies (HICs) focus on the knowledge and skills necessary to be considered proficient at using the technology necessary in a given role in healthcare (Hunter et al., 2013; Yasnoff et al., 2000).

The importance of HICs has been argued by various governing bodies in healthcare, such as the American Nurses Association (American Nurses Association (ANA), 2015). They are seen by some as a way to facilitate the adoption and effective use of technology in healthcare organizations (Westra et al., 2008; Hebert, 2000; Grobe,

1989; Staggers et al., 2001; Staggers et al., 2002; Curran, 2003). In nursing, where HICs are often referred to as Nursing Informatics Competencies (NICs), they are seen as a viable approach in which to transform the practice of nursing to new levels (Zytkowski, 2003), and they are incorporated into various higher education institutions that train nurses (McNeil et al., 2005) and public health practitioners (Bernstein et al., 2015; Arocha & Hoffman-Goetz, 2012). They are commonly used to demonstrate the effectiveness of various informatics educational interventions (Desjardins et al., 2005; Yu et al., 2015).

Research in the area has predominantly focused on developing instruments for self-evaluation in the various healthcare disciplines such as various types of nurses (Curran, 2003; Staggers et al., 2001). Many of these studies report on the results of expert panel studies, which are tasked with developing these lists of competencies for their various contexts. A more robust approach entails developing different levels of competencies within a discipline. For example, beginning nurse, experienced nurse, informatics nurse specialist and informatics innovator are four tiers of a NIC model developed for the nursing discipline (Staggers et al., 2001).

O'Carroll and the Public Health Informatics Competencies Working Group (2002) provides a relevant example, focusing on the HICs of public health professionals. They define competency as a "public health worker's observable or measurable performance, skill, or knowledge related to the systematic application of information and computer science and technology to public health" (p. 7). Three classifications of competencies are

used. First, *effective use of information* (EUInfo) includes skills related to analyzing data, basic research methods, and information retrieval and appraisal. Second, *effective use of information technology* (EUTech) pertains to the ability to improve individual performance by using computing devices, software and e-learning tools, and combining information from separate sources to develop new knowledge. Third, *effective management of information technology projects* (EMProj) includes the ability to advocate for changes in technologies in the organization, participate in information technology projects, procure new technologies for the organization, and ensure the appropriateness of technologies according to the needs of the populace. It is important to note that these classifications do not represent phenomena and should not be treated like constructs, as they have not been validated psychometrically, as in other competency models (Constantine et al., 2002; Nelson et al., 2008). Table 2.1 (below) contains an illustrative group of studies that contain informatics competency models for use in various contexts and roles in healthcare.

Table 2.1: Various informatics competencies models developed for a variety of roles in healthcare

Reference	Use
(American Nurses Association (ANA), 2015)	Nurses
(Westra et al., 2008)	Nursing and Healthcare Leaders
(Jensen et al., 2016)	Nursing Managers
(Hwang & Park, 2011)	Nurses
(McNeil et al., 2005)	Nurses
(Ozbolt & Graves, 1993)	Clinical Nurses
(Staggers et al., 2002)	Nurses
(Yoon et al., 2009)	Nurses
(Whittaker et al., 2015)	Public Health
(Chang et al., 2011)	Variant of (Staggers et al., 2002) for Nurses in Taiwan
(Ayres et al., 2012)	Nutrition, across all levels
(Yasnoff et al., 2000; O'Carroll, 2002)	Public Health

2.2.1 Limitations of the Competency Approach

The chief limitation of using the competency approach is that there is very little research establishing HICs as impacting other variables; most importantly, performance and outcome related variables, clinical and otherwise. This is despite the widespread use of competency models in healthcare, the richness of models in describing the competencies needed to use technology in various roles and, most importantly, the original intent of the pioneers of this approach (McClelland, 1973; Mirabile, 1997). Such research is needed to demonstrate the value of these competencies to their organization and healthcare systems. Indeed, a few recent studies hypothesize HIC proficiencies as either independent or dependent variables at the individual level, and none are known to exist that relate the group level HICs to organizational outcomes. One study (Lee et al., 2015) has reported a link between some of the HICs as defined by Staggers (2002) to job

satisfaction, perception of informatics, and nursing competency in a sample of Korean hospital nurses. Another study (Green et al., 2016) focused on nurses in a hospital setting, and reported a link between competencies as defined by the Technology Informatics Guiding Educational Reform (TIGER) initiative (The TIGER Initiative, 2006), and decision making satisfaction, as well as a moderating influence on this relationship with user satisfaction of the software they use. Another study (Lin et al., 2014), using the DeLone and MacLean (2003) framework, reported that NICs along with information systems success positively influenced nurses' clinical and informatics knowledge, and their relationships with their various stakeholders. They define information systems success as certainty of the information produced by the system, quality of technical support, and perceived sufficiency of privacy safeguards. Other studies have focused on skillsets of individual healthcare practitioners other than HICs. For example, Lin et al. (2014) report that nurses' user satisfaction is positively linked to nursing care performance.

Although this research gap exists, several paramedicine governing bodies have identified the need for employees operating in this role to be able to use various technologies (National Highway Traffic Safety Administration (NHTSA), 2013; National Registry of Emergency Medical Technicians (NREMT), 2000; EagleCounty.us, 2013; EMSCC, 2011). As healthcare in general has had difficulty adopting technology (Pew, 1998; Mantas et al., 2010) and paramedics in particular have experienced work related stress due to under-defined scopes of practice and roles (Cooper & Grant, 2009; Ball,

2005), it is imperative that research on HICs, specifically within the context of paramedicine, be conducted. In short, there is a well-established body of knowledge for HICs, yet evidence lacks as to the competencies needed by paramedics, and their impact on various outcomes.

2.3 Dynamic Capabilities

The DC view originates from the RBV of the firm. The RBV explains the performance of a firm as originating from the unique resources possessed by that firm, and the ability of the firm to deploy strategies that exploit their resources. In this view, firm resources include a wide array of strategically relevant assets, including physical assets as well as knowledge, information, processes and capabilities (Wernerfelt, 1984). These assets enable a firm to conceive and implement strategies that increase efficiency and effectiveness of the firm, leading to a source of performance gains. Assets can include physical (Williamson, 1975), human (Becker, 1964; Ployhart & Moliterno, 2011) and organizational (Tomer, 1987) resources (Barney, 1991). The unique characteristics of these resources among firms is what allows for competitive advantage over existing, emerging and potential firms. After attempts to duplicate these resources by competing firms have tried and failed, the resources are seen as a source of sustained competitive advantage (Barney, 1991). Changes in the environment may render resources more or less relevant over time (Teece, 2007; Eisenhardt & Martin, 2000).

As the RBV evolved, it was seen that possession of resources alone was not enough to gain performance benefits. The notion of capability was introduced, which

refers to the abilities of the firm that are necessary to properly use the resources they possess (Winter & Nelson, 1982). Capabilities exist as collections of organizational routines (Winter, 2003), and effective capabilities are necessary to achieve high performance (Winter & Nelson, 1982). There are various types of capabilities that focus on different aspects of the firm. Operational capabilities focus on the day to day operations of the firm, or "how you earn your living" (Helfat & Peteraf, 2003; Winter, 2003). Other capabilities focus on subareas of the firm, such as Information Technology (Tanriverdi, 2005; Devaraj & Kohli, 2003) and Human Resources (Pearce & Robinson, 2004) related capabilities.

DCs focus on how organizations are able to react to changing conditions in the environment, as all organizations are set in environments that change to varying degrees (Zollo & Winter, 2002). They refer specifically to capabilities of a firm to reallocate their resources in order to match changes in their environment, for the purpose of maintaining superior business performance in the long-term (Teece, 2007; Helfat & Peteraf, 2003; Helfat, 1997). These capabilities exist as sets of routines (Winter, 2003), and are distinct from operational capabilities. Whereas operational capabilities are used to complete the day-to-day business processing, DCs are used to reconfigure these operational capabilities when deemed necessary by changes occurring in the environment, with technology, and in other relevant ways (Winter, 2003; Eisenhardt & Martin, 2000; Teece et al., 1997). Operational and dynamic capabilities have been referred to as zero-order and first-order capabilities, respectively (Winter, 2003). Although the DC approach is not widely used in

healthcare, some research surrounding this topic in healthcare has been from the interpretive approach, resulting in a rich narrative of DCs and how they are developed, and other context-specific descriptions (Singh et al., 2011; eg. Davison & Hyland, 2002; Pablo et al., 2007). Despite debate surrounding the topic, several researchers maintain that DCs exist as a set of "identifiable and specific routines" (Eisenhardt & Martin, 2000), and are indeed not ambiguous, tacit, or otherwise difficult to identify, although unique to each organization (Galunic & Eisenhardt, 2001).

2.3.1 Dimensions of Dynamic Capabilities

Building on the classification of DCs proposed by Teece (1997; 2007), Pavlou and El Sawy (2011) propose a general framework with the intent of pursuing quantitative research on DCs. This framework has been applied to a variety of disparate contexts, including new product development (Pavlou & El Sawy, 2011), hospitality management (Nieves & Haller, 2014), green product development (Chen & Chang, 2013), and healthcare related areas (Wang et al., 2013). Firm performance, the distal outcome, is predicted by a framework that is comprised of *Sensing*, *Learning*, *Integrating* and *Co-ordinating Capabilities*. These four dimensions of DCs were conceptualized to capture all relevant activity from perception of the need to change to the implementation of a model that addresses the new state in the environment:

- **Sensing Capabilities** includes routines that are associated with identifying, interpreting and pursuing opportunities in the environment. Market and environmental trends and intelligence are surveyed and interpreted, and ideas that are significant for

the organization. Decisions are made whether ideas are important for the firm. These processes involve generating (Galunic & Rodan, 1998), disseminating (Kogut & Zander, 1996) and responding (Teece, 2007) to intelligence.

- **Learning Capabilities** include those that apply new knowledge to existing operational routines. Once a relevant idea has been detected, it is contextualized to the organization, and enables the reconfiguration of existing operational processes. Also referred to as absorptive capacity (Zahra & George, 2002), these routines involve acquiring, assimilating, transforming, and exploiting knowledge (Zahra & George, 2002).
- **Integrating Capabilities** entails combining knowledge from individuals into the operational capabilities. As individuals learn how knowledge applies to the organization, it will be shared throughout members of the organization, and integrated into an overall collective sense. This collective sense is constructed in preparation for change, and is meant to facilitate the change that will occur when resources are actually deployed (Zahra & Nielsen, 2002). These routines involve contributing knowledge to the group level (Okhuysen & Eisenhardt, 2002), representing individual and group knowledge (De Boer et al., 1999; Crowston & Kammerer, 1998), and interrelation of knowledge into a collective system (Grant, 1996b).
- **Coordinating Capabilities** refers to the ability to deploy resources and labor to new operational capabilities. This capability is associated with the orchestration of individual activities associated with change. They involve assigning resources to tasks

(Helfat & Peteraf, 2003), appointing the right person to tasks (Eisenhardt & Brown, 1999), identifying synergies among tasks (Eisenhardt & Galunic, 2000), resolving conflict (Zahra & Nielsen, 2002) and orchestrating activities (Henderson, 1994).

2.4 Information Technology Capabilities

Research using the RBV has demonstrated the contribution of ICTs to firm performance (Tanriverdi, 2005; Devaraj & Kohli, 2003). A chief contribution of these efforts concerns the importance of firm level capabilities related to exploiting technology owned by the firm (Piccoli & Ives, 2005; Bharadwaj, 2000; Ha & Jeong, 2010). In other words, mere possession of technology does not contribute to firm performance; firms must have established the appropriate and effective organizational processes to properly exploit their technology resources. Information Technology Capabilities, or IT Capabilities, refers to these organizational routines related to exploiting technology (Grant, 1991; Grant, 1995; Bharadwaj, 2000; Ha & Jeong, 2010; Piccoli & Ives, 2005). In establishing links between IT Capabilities and firm performance, many unique approaches have been used, differing either by how IT Competencies are conceptualized, or whether their impact on performance is direct. Bhatt & Grover (2010) find that both the degree to which business domain knowledge is possessed by the IT department, and the degree to which the relationship between IT and business managers is a positive one, will directly influence firm performance. Kim et al. (2011) found that the flexibility of the IT infrastructure and the expertise of the IT personnel influenced the ability of a firm to reconfigure operational processes to reflect their environment, which in turn influenced

the firm's financial performance. Other examples of IT Capabilities include the managerial capabilities of IT executives (Liu et al., 2013), as well as support team IT expertise and its degree of integration into the rest of the firm (Ordanini & Rubera, 2010).

Integrating with other firms in various ways (for instance sharing data with other supply chain partners), is often a goal of organizations. This integration is often accomplished through IT, and typically results in improved DCs and performance. Much of the evidence supporting integration with external partners comes from the supply chain. Rai & Tang (2010) find that both the ability to integrate new data and technology and the ability to reconfigure and extend existing IT resources play a role in firm competitive advantage across several sectors, specifically when a certain level of flexibility within the firm is needed to properly take advantage of external resources. Wong et al. (2011) demonstrates organizational performance benefits for integration with both suppliers and customers on a supply chain. Fawcett et al. (2011) demonstrate that willingness to share information among supply chain members positively impacts operational performance. Tian et al. (2009) demonstrate that, in a sample of Chinese firms, IT flexibility positively impacts competitive advantage, as does the alignment between business and IT strategies.

Although applications of IT Capabilities in healthcare do exist, there are very few such studies. Several case studies in healthcare have revealed substantial support for individual knowledge to have an impact on the performance of a healthcare organization. These include the ability to share and integrate knowledge contributing to palliative care

patient needs (Davison & Hyland, 2002), employee desire to change (Ridder et al., 2007), and the ability to appraise new technologies against existing processes (Singh et al., 2011). These findings taken together suggest that technology in the healthcare organization seems to help DCs to make the organization able to adapt to changing environmental forces. Despite this it takes human involvement to contribute to performance gains. Therefore, it is likely that healthcare workers in possession of some sort of competency with technology are needed to contribute to the reconfiguration of resources and improved organizational performance.

2.5 Integration of Individual Knowledge and Organizational Capabilities

The contribution of firm member knowledge and abilities to organizational capabilities is a widely theorized topic. Several theoretical approaches link the knowledge of the individual with the activities that take place in a firm and its subsequent performance. Three in particular are: the microfoundations approach, the Knowledge Based View (KBV) of the firm, and the Human Capital Resources (HCR) approach. From the DC view, microfoundations (Teece, 2007) refer to elements in a firm's control that contribute to DCs of the firm. These can include knowledge, skills and other attributes (KSAOs) of the individual (Griffith & Sawyer, 2010; Teece, 2007). The ability of the firm to recognize opportunities in part relies on the individual's ability to recognize them, which in turn relies on the individual's existing knowledge, learning capabilities and ability to understand the customer, as well as initiate and pursue action towards a goal (Nonaka & Toyama, 2007).

The KBV, another theoretical offshoot of the RBV, is based on the view that knowledge is the most important resource in the firm's control (Grant, 1996b; Spender, 1996). The firm is seen as an environment where all activity is, in some form or another, the creation and application of knowledge. Knowledge can exist as explicit or tacit knowledge (Nonaka & Takeuchi, 1995). The former refers to knowledge that can be or is codified some manner, and the latter exists only within humans as skillsets and other forms that are difficult to codify. Both types are seen as an input to operational processes. The ability to transfer and integrate knowledge among many firm members is essential in building organizational capabilities because it allows them to perform the specialized and unique tasks necessary for the firm to create value (Grant, 1996b). This can be accomplished by various organizational learning mechanisms, such as maintaining a shared mental model among firm members (Kim, 1993). Knowledge can be acquired from outside the firm, or developed internally (Bierly & Chakrabarti, 1996).

HCR refers to "a unit-level resource that is created from the emergence of individuals' knowledge, skills, abilities, and other characteristics (KSAOs)" (Ployhart & Moliterno, 2011, p.128). These skills emerge to become group level phenomena through various processes. These processes, or social contextual factors, include behavioural processes that make individuals' behaviour interdependent (Kozlowski & Ilgen, 2006). They also share cognitive states of members with respect to goals and leadership (Ployhart & Moliterno, 2011), along with work processes and other factors, and affective states that include emotional bonds within the group, for example group cohesion

(Hackman, 1987). Although contextual considerations are an important part of this approach, researchers have conceptualized and operationalized unit-level HCRs in a multitude of ways, including direct measure of skills of unit members (Nyberg et al., 2014).

As well as a theoretical basis for the contribution of individual knowledge to firm capabilities, empirical studies have demonstrated this. Chien and Tsai (2012) found that knowledge resources and learning mechanisms had a positive effect on DCs of a firm. In this case, knowledge resources refer to the knowledge that exists within individual members of the firm (Grant, 1996b), and learning mechanisms are the established activities that help organization members gain knowledge (Popper & Lipshitz, 1998). (Hung et al., 2010) also demonstrated that an organizational learning culture among its members impacts the DCs of the organization in a sample of Taiwanese technology companies. Gardner, Gino & Staats (2011) found support for the influence of the ability to integrate knowledge on performance at the team level. Regarding the measurement of knowledge at the group level, evidence supports both the viability of group-level variables from the aggregations of individual-level variables, and their ability to impact group-level outcomes using multilevel theoretical models (Griffith & Sawyer, 2010; Li et al., 2008; Yuan et al., 2010; Ployhart et al., 2006; Marrone et al., 2007). This in turn speaks to the notion of a "shared knowledge" (Ployhart et al., 2006) existing at the group level. In a qualitative study involving a diverse group of firms, Kindström, Kowalkowski, & Sandberg (2013) explore microfoundational factors that lead companies to develop

DCs in order to improve their innovation performance. The study found that sensing opportunities largely involved building up knowledge in four places: customers, relevant external service providers, internal structures, and technological innovations. As well, relevant capabilities for seizing opportunities were founded on the ability to interact with customers and service partners, the ability to swiftly restructure service delivery processes when needed, and the ability to identify areas where value might be created. Finally, reconfiguring capabilities entail the ability to orchestrate resources both within and external to the firm, as well as the ability to create a mental model for adopting new behaviors and abandoning obsolete ones.

2.6 Literature Review Summary

The purpose of this chapter is to present the results of a literature review that supports the purpose of this study. As previously articulated, the purpose of this dissertation is to determine how paramedic services innovate, and how that innovation is influenced by technology in particular. Two main areas of the literature were reviewed. First, HICs are a currently popular approach to capture the various skills and knowledge that healthcare professionals have with using IT in their job roles. Second, DCs capture the ways in which organizations can reconfigure resources and operational capabilities in order to reflect changes in their environment, and maintain a high level of performance. A theoretical basis for integrating individual level knowledge and organizational capabilities is stated in several theoretical approaches, specifically the HCR approach (Ployhart & Moliterno, 2011), the concept of microfoundations, (Teece, 2007) and the KBV of the

Firm (Grant, 1996b; Spender, 1996). These approaches theorize that individual characteristics can impact features of the organization; this implies that a multilevel model (Hox, 2002) can be constructed in order to test this theory. This literature will be used in the following chapter to construct a theoretical model, which will be subsequently tested as part of this study.

Chapter 3: Theoretical Development

The purpose of this chapter is to present a theoretical model that supports the purpose of this research, as stated earlier, which is to determine how paramedic services innovate, and how that innovation is influenced by technology in particular. The theoretical model in this chapter is used in subsequent chapters to answer the first three research questions: (RQ1) *Do the organizational abilities to reconfigure and integrate with other community partners influence the ability of the paramedic service to innovate?* (RQ2) *Do IT Service Provider related capabilities influence a paramedic service's ability to innovate?* and (RQ3) *Do the technology-related knowledge and skills possessed by paramedics influence the ability of their respective services to innovate?*

The model presented in this chapter was constructed by integrating various theoretical approaches as described in the previous chapters. At a high level, group-level HICs along with IT Capabilities are posited to impact various dimensions of DCs in varying configurations. DCs are then posited to impact Service Innovation Performance, or the ability of the service to successfully develop impactful service delivery models. As no factor structure for the HICs has been established, this section will explain an Exploratory Factor Analysis (EFA; Bryant & Yarnold, 1995) that has been conducted on a set of HIC items, allowing factors to be detected and integrated into the theoretical model. This technique is not widely used in information systems research, but is justified as an *abductive* approach to detecting phenomena for the purpose of hypothesis

construction (See the Exploratory Factor Analysis section in this chapter for detailed justification of this technique).

3.1 Model Development

Figure 3.1 (below) describes the theoretical model that will be used to guide this research. It follows the premise that the impact of IT Capabilities on performance is mediated by DCs (Kim et al., 2011); as well, the individual knowledge impact DCs of the organization (Teece et al., 1997; Teece, 2007). The conceptualization of DCs follows that of Pavlou & El Sawy (2011), where DC is a higher order latent variable comprised of several lower order latent variables as described in Chapter 2 above: *sensing, learning, integrating* and *co-ordinating* capabilities. The related hypotheses all pertain to how DCs are somehow impacted by various resources and other capabilities in the control of the firm, in various configurations. Following the advice of Cadogan & Lee (2013), the set of hypotheses were developed to theoretically link these capabilities and resources to the lower order dimensions of DCs, rather than the higher order latent variable. As argued by Cadogan & Lee (2013), hypotheses that link antecedents with higher order constructs tend to obscure results, as it is not clear as to what lower order construct of the more abstract higher order construct is impacted by the antecedent. Although hypothesizing a relationship between an antecedent and lower order construct is not widely used in information systems research, there are a few examples. For example, Pavlou & Fygenson (2006) present support for several antecedents of controllability and self-efficacy, two latent variables that are modeled as lower order constructs of a higher order

concept representing perceived behavioural control. As another example (Grgecic et al., 2015), in a supplement to their main analysis, found that various latent variables modeled as antecedents to indicators of a higher order construct were related at different significance levels, despite a significant relationship reported between the antecedents and the higher order construct. As per Pavlou & El Sawy (2011), a global measure of reconfiguration capabilities is included for model identification purposes. More details regarding the hypotheses in this model follows.

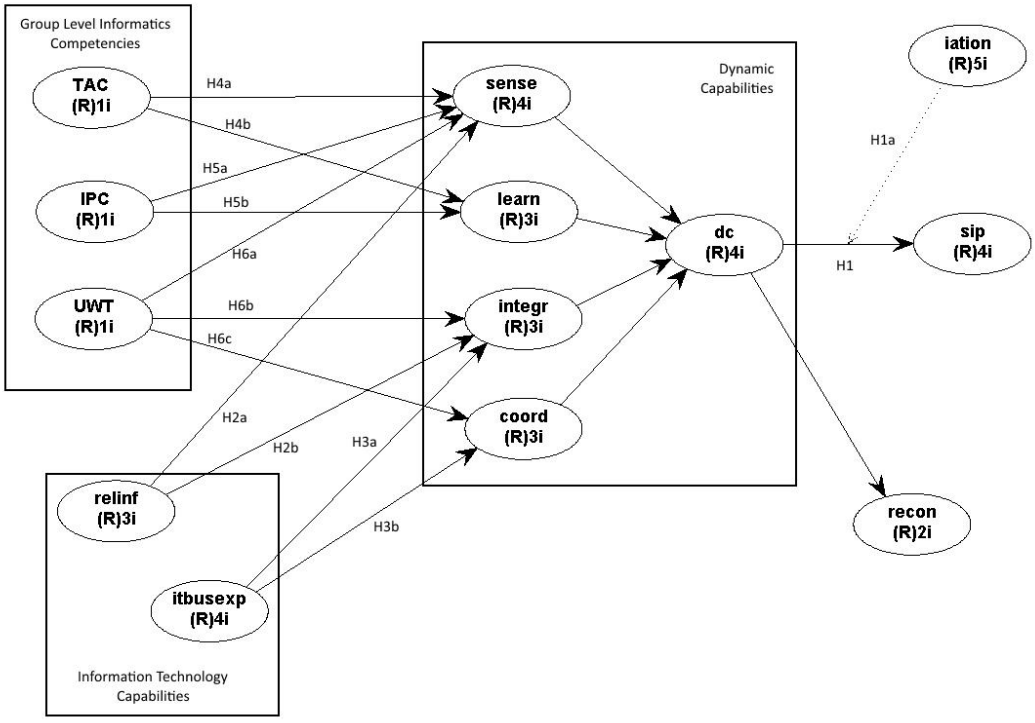

Figure 3.1: Theoretical model to be tested in this research. TAC: Technology Application Competencies. IPC: Information Processing Competencies. UWT: Understanding of the Workings of Technology. Relinf: Relationship Infrastructure. Itbusexp: IT Business Expertise. Sense: Sensing Capabilities. Learn: Learning Capabilities. Integr: Integrating Capabilities. Coord: Coordinating Capabilities. DC: Dynamic Capabilities. Iation: Integration. Recon: Reconfiguring Capabilities. SIP: Service Innovation Performance.

Table 3.1 (below) organizes the hypotheses that comprise the theoretical model presented in this chapter. The overall goal of this model is to answer the first three research questions posted in Chapter 1, and the hypotheses are grouped by the research questions that they support. The antecedents identified in H4-H6 – Technology Application Competencies, Understandings of the Workings of Technology, and Information Processing Competencies – are labels of the factors emerged from the EFA that is presented in this chapter, and will be explained in detail in the Exploratory Factor Analysis section (below).

Table 3.1: Summary of the hypotheses proposed in the theoretical model proposed in this chapter. The hypotheses are grouped by the research questions they support.

RQ1	**Do the organizational abilities to reconfigure and integrate with other community partners influence the ability of the paramedic service to innovate?**
- H1	Dynamic Capabilities will positively impact Service Innovation Performance.
- H1a	Integration with other healthcare organizations will amplify the relationship between Dynamic Capabilities and Service Innovation Performance.
RQ2	**Do IT Service Provider related capabilities influence a paramedic service's ability to innovate?**
- H2a	Relationship Infrastructure will positively impact Sensing Capabilities
- H2b	Relationship Infrastructure will positively impact Integrating Capabilities
- H3a	IT Business Expertise will positively impact Integrating Capabilities
- H3b	IT Business Expertise will positively impact Co-ordinating Capabilities
RQ3	**Do the technology-related knowledge and skills possessed by paramedics influence the ability of their respective services to innovate?**
- H4a	Group-Level Technology Application Competencies will positively impact Sensing Capabilities.
- H4b	Group-Level Technology Application Competencies will positively impact Learning Capabilities.
- H5a	Group-Level Technology Application Competencies will positively impact Sensing Capabilities.
- H5b	Group-Level Technology Application Competencies will positively impact Learning Capabilities.
- H6a	Group-Level Understanding of the Workings of Technology will positively impact Sensing Capabilities
- H6b	Group-Level Understanding of the Workings of Technology will positively Integrating Capabilities.
- H6c	Group-Level Understanding of the Workings of Technology will positively impact Co-ordinating Capabilities.

3.1.1 Performance

The first hypothesis refers to the ability of the DCs of the organization to impact firm performance. This key hypothesis in the RBV and DC literature (Eisenhardt & Martin, 2000; Teece et al., 1997; Wernerfelt, 1984), has been supported in diverse contexts, including new product development (Pavlou & El Sawy, 2011), small and medium sized enterprises (Loefsten, 2014) and green product development (Chen &

Chang, 2013). In this case, the ability of a firm to reconfigure resources will impact the ability of a paramedic service to develop successful service delivery models. Performance here is adapted from the Service Innovation Performance (SIP) variable (Menor & Roth, 2007), which captures the degree to which companies believe that they successfully implement services that match their customers' needs better than their competition. The use of perceptual measures of performance is widely accepted in RBV research (Powell & Dent-Micallef, 1997; Tallon et al., 2000), as they have been shown to correlate well with objective measures (Venkatraman & Ramanujam, 1987), therefore:

> *H1: Dynamic Capabilities will positively impact Service Innovation Performance.*

3.1.2 Integration with other Healthcare Services

With respect to scopes of practice among different healthcare providers, overlap of services does occur in Canada. It is likely to increase in the future, as it is seen as a way to reduce conflict among professions and provide better care. Therefore exclusive scope of practice regulations should be relaxed, and on some occasions, shared (Epstein et al., 1998). It is plausible that initiatives from paramedic services will implement programs that compete with other healthcare providers, yet the spirit of many of these innovations is to seek out ways in which integration can be achieved with other healthcare providers (Paterson et al., 2006). A potential way to ensure that integration does occur rather than overlap is to allow the paramedic service to engage its healthcare partners when implementing changes. This way, initiatives can be developed so that duplication with other organizations can be avoided, while complementing or integrating with others.

In the context of supply chain management, Supplier Integration has been defined as the degree to which suppliers are involved in joint strategic collaboration related to shared business processes, data and information, planning, development of offerings, and so on (Lai et al., 2010; Ragatz et al., 2002; Wong et al., 2011). It has been linked to operational (Wong et al., 2011) and strategic (Sanders, 2005) performance. Indeed, Canadian cases exist where integration between paramedic services and other healthcare providers have resulted in system level benefits. Decter (2014) describes a case, among others, where paramedics are deployed to long-term care homes to conduct patient visits, resulting in a dramatic reduction of ambulance transports that otherwise would have happened because of normal policy. This innovation resulted in several industry and government awards. Here it is theorized that the degree to which the strategic processes of a paramedic service is integrated with other healthcare organizations will enhance its ability to be locally relevant, and subsequently have a higher rate of strategic success. This is theorized to be so, as external feedback may help ensure that services are more unique or collaborative as applicable, and therefore valuable to citizens and patients in the service region. Therefore:

> *H1a: Integration with other healthcare organizations will amplify the relationship between Dynamic Capabilities and Service Innovation Performance.*

3.1.3 IT Capabilities

As previously explained, IT Capabilities refer to the organizational processes related to the exploitation of technological resources in the control of the firm (Grant, 1991; Grant, 1995; Bharadwaj, 2000; Ha & Jeong, 2010; Piccoli & Ives, 2005). Due to the complexities inherent in healthcare, this research focuses on Relationship

Infrastructure and IT Business Expertise, two IT Capabilities that speak to developing a shared understanding between the healthcare practitioners and the staff of the IT providers or department. Relationship Infrastructure, one IT Capability in particular, refers to the quality of the relationship between paramedic leaders and IT leaders, with respect to trust, respect and sharing responsibility for the success of IT projects (Ross et al., 1996). A healthy relationship infrastructure allows for knowledge to be more effectively accessed and shared between IT and functional leadership (Tsai, 2001; Martin, 2010). Previous studies have found that Relationship Infrastructure impacts DCs (Bhatt et al., 2010; Bhatt & Grover, 2005), competitive advantage (Bhatt, 2003; Bhatt & Grover, 2005), and long-term competitiveness (Ross et al., 1996). It is anticipated that a good relationship between these two parties will benefit the organizational sensing capabilities. A more informed Paramedic Leader with regards to new and emerging technologies should result from a paramedic service where the Paramedic Leaders collaborate, share risk and interact with their IT managers (Bhatt et al., 2010; Ross et al., 1996). Therefore:

> *H2a: Relationship Infrastructure will positively impact Sensing Capabilities.*

The Integrating Capabilities of the paramedic service will also benefit from a good Relationship Infrastructure between the IT and paramedic leadership. As articulated by Zahra et al. (2006), the process in which functional managers strategically choose which improvements to pursue is quite complex (Burgelman, 1991). This process is shaped by many factors including view of the environment, the current capabilities in the organization, resources available, and many other complex factors. A coherent outcome

of this process is desired, as this will influence the shared model that the members of the organization will have, and reinforce a positive expectation of the change (Zahra et al., 2006). In this process, functional managers are likely to benefit from the advice of the IT managers, resulting in a higher quality model in which to communicate to the staff. Therefore, it is hypothesized:

> *H2b: Relationship Infrastructure will positively impact Integrating Capabilities.*

The second IT Capability included in this model is IT Business Expertise, which refers to the domain-related expertise possessed by the IT department (Sambamurthy & Zmud, 1997). Several researchers attribute the success of the firm to the business-related knowledge of IT staff (Clark et al., 1997; Keen, 1991; Sambamurthy & Zmud, 1997; Ross et al., 1996; Feeny & Willcocks, 1998; Bhatt & Grover, 2005). Business domain knowledge of the IT staff has been linked to the success of IT projects (Fisk et al., 2010; Tesch et al., 2009), competitive advantage (Bhatt & Grover, 2005), organizational IT-dependent strategic agility (Fink & Neumann, 2007), process oriented DCs (Kim et al., 2011), and intention to form partnerships with business clients (Bassellier & Benbasat, 2004). The focus of these next two hypotheses has been limited to Integrating and Co-ordinating Capabilities, as it is believed that the IT staff will be more involved during times where plans are actually being executed, rather than when plans are being formulated.

Integrating Capabilities captures the perceptions of knowledge of who in the group has specialized knowledge relevant to specific jobs, effectiveness of interrelating

activities, and effectiveness in making group contributions, so that this knowledge may be combined into a collective sense (Grant, 1996b; Zahra & Nielsen, 2002). It is believed that the IT staff business expertise can only be known when they are more visible to paramedic leadership that have these capabilities in the first place, and this awareness of the IT staff business expertise is improved when the IT staff are more effective at communicating with paramedics and paramedic leadership, in a paramedicine context. The knowledge of the IT staff can thus be accessed more easily when needed. Therefore:

> *H3a: IT Business Expertise will positively impact Integrating Capabilities.*

Co-ordinating capabilities capture the ability to assign people with appropriate knowledge to specific tasks, as well as information, time and other resources (Pavlou & El Sawy, 2011). It is believed that an organization whose IT staff have a higher business expertise will enhance the ability of the organization to apply their skills to tasks as needed. When changing healthcare processes, the IT provider staff's clinical knowledge is an important safeguard against any potential adverse effects of change (Walker & Carayon, 2009). Given that IT Business Experience is shown to impact success of IT projects (Fisk et al., 2010; Tesch et al., 2009), competitive advantage (Bhatt & Grover, 2005; Bhatt, 2003), organizational IT-dependent strategic agility (Fink & Neumann, 2007), it is assumed that the effectiveness of efforts to coordinate change will be enhanced by the ability of IT staff to communicate with medical personnel and leaders. Therefore:

> *H3b: IT Business Expertise will positively impact Co-ordinating Capabilities.*

3.1.4 Healthcare Informatics Competencies

To complete the development of the theoretical model, EFA will now be performed on the HIC items with the responses from paramedics who participated in the study. Although it is not common in information systems research to feature an EFA in the theoretical development section, other areas of research employ this statistical technique to preliminarily detect the presence of factors to be used in theoretical models (Conway & Huffcutt, 2003). A few examples of this include applications in decision support systems management (Benamati & Lederer, 2008), user acceptance of text messaging as a health intervention (Carter et al., 2015), and the continuous use of business intelligence systems (Bischoff et al., 2015).

Use of EFA in an *a priori* manner is an application of the abductive scientific method (Haig, 2005a; Haig, 2005b). Whereas *inductive* methods develop knowledge by focussing on observing cases and generalizing it to a wider reach, and *deductive* methods develop knowledge by constructing and quantitatively testing hypotheses, *abductive* methods are used to detect phenomena through empirical methods. Abductive methods are particularly useful as a supplementary tool when developing hypotheses (Haig, 2005a), rather than as a mainstream theory of scientific method, as inductive and deductive methods are known (Laudan, 1981). This research employs EFA in this innovative manner because the psychometric properties of these HICs have not previously been detected in this context. Therefore, the factor structure of the competency model is unknown. The researchers feel that there was enough theoretical and empirical

justification in the literature to initiate the collection of data, but this data needs to be explored in detail to develop a sound theory.

The competency model used in this research is adapted from O'Carroll (2002). In this model, the items are organized into one of three categories: Effective Use of Information, Effective Use of Information Technology and Effective Management of Information Technology Projects. It is important to note that these are only *categories*, and not factors, constructs, or otherwise established in a manner that justifies valid and reliable representation of any phenomena. In addition, as these competencies are measured at the individual level, it is not established that these competencies have emerged at the group level (Kozlowski et al., 2013), which is necessary to establish when conducting multilevel research. Therefore, these categories cannot be substitutes for latent variables. This was verified by computing the Cronbach's alpha, Intraclass Correlations (ICC(1) and ICC(2); Shrout & Fleiss, 1979) and within-group agreement (r(wg); Bliese, 2000) for each of the categories, which yielded poor results.

3.1.4.1 Exploratory Factor Analysis

EFA (Bryant & Yarnold, 1995) was performed in order to detect any factors from the competency items in the individual level of the dataset. Data used for this portion of the study was collected as part of the main data collection phase of the study (only a brief summary of details will be given here. See Chapter 4 for detailed data collection and analysis methods and Chapter 5 for more detailed description of the sample). 502 paramedics from the 43 participating EMS services submitted complete questionnaires

containing items in which they self-rated their informatics competencies. The competency model for public health professionals presented in O'Carroll (2002) was selected, adapted in consultation with Paramedic Leaders, and pre-tested with 4 paramedics from Ontario and Alberta. The original instrument contains 27 items (See Appendix A – Paramedic Instrument and Recruitment Material).

To determine the suitability of the data for EFA, The Kaiser-Meyer-Olkin (KMO; Kaiser, 1970) measure of sample adequacy and Bartlett's (Bartlett, 1954) test of sphericity are reported. Both tests suggest that EFA is suitable for this dataset. The KMO is 0.97, which is above the recommended level of 0.6 (Kaiser, 1970), and the Bartlett's test is significant ($p < 0.000$), both indicating the suitability of the data for factor analysis. Missing cases were deleted pairwise, and varimax rotation was used. Three items were eliminated as they either did not have loadings greater than 0.5 on any one factor, or did not load on only one factor, resulting in 24 items being retained. Three factors with eigenvalues greater than 1 explaining 61.9% of the variance emerged, explaining 50.19%, 6.98% and 5.55% of the variance, respectively.

Table 3.2 (below) summarizes the results, with the results for each of the three factors shown in the three columns to the right of the table (See Appendix B – Factor Loadings for HIC Items for the entire result set). Factor loadings less than 0.4 are not shown.

Table 3.2: Factor model for healthcare informatics capabilities. Factor loadings less than 0.4 are not shown.

Category	Item	Factors		
		1	2	3

EUInfo	Develop, implement, and evaluate a community public health assessment	**.69**		
EUTech	Utilize modern information technology as a tool to promote public health	**.58**	.42	
EUTech	Design a website that helps users find health-related information	**.77**		
EUTech	Use technology to broadcast health-related news, alerts, and advisories	**.59**		
EUTech	Characteristics, functionalities and examples of systems to support patients	**.67**	.42	
EMProj	Describe at a basic level technologies employed to ensure computer security	**.61**		.41
EMProj	Describe new technologies and how they might improve public health practice	**.65**	.44	
EMProj	Name technologies available for delivering distance learning to the learner	**.59**		
EMProj	Monitor public health information systems development efforts	**.65**	.40	
EMProj	Identify major systems' development efforts that may impact public health practice	**.75**		
EUInfo	Evaluate the integrity and comparability of data and identify gaps in data sources	.42	**.61**	
EUInfo	Obtain and interpret information regarding risks and benefits to the community		**.66**	
EUInfo	Collect, summarize, and interpret information relevant to an issue		**.73**	
EUInfo	Effectively present demographic, statistical, programmatic, and scientific information for professional and lay audiences	.48	**.58**	
EUInfo	Identify and retrieve current relevant scientific evidence		**.72**	
EUTech	Identify special-purpose search engines and retrieve public health-specific information	.45	**.53**	
EUTech	Assess validity and authoritativeness of information retrieved from online sources		**.67**	
EUTech	Identify information sources that are potentially relevant to public health	.49	**.54**	
EUTech	Appropriately combine, interpret, and utilize data and information from multiple sources to create new information and knowledge		**.76**	
EMProj	Regularly scan literature for technology and applications to public health	.46	**.55**	
EUInfo	Use the media, advanced technologies, and community networks to communicate			**.53**
EUTech	Use browser software to navigate the World Wide Web			**.82**
EUTech	Use general purpose online search engines to search the web (e.g. Google, Yahoo!)			**.79**
EMProj	Describe at a basic level the Internet and World Wide Web			**.74**

The sample size (n=502) is assessed *a posteriori* here. Although there are several guidelines for suitable sample sizes in EFA (such as minimum item-to-participant ratios), some research has shown that number of absolute responses is the best predictor of stable results, and in numbers below 300, the cut-off point for item loadings (Guadagnoli & Velicer, 1988). Considering this, it is assumed that 502 responses is suitable to generate stable results.

3.1.4.2 Interpreting the Competency Factors

The results of the previous step indicate that the factors that emerged and the grouping labels for the original categories do not match. In Table 4.1 (above) the three emerged factors each contain items from all three categories, which further demonstrates that the categories have no psychometric basis. These new factors were labeled with the assistance of a senior Paramedic Leader and an academic, after failing to agree that any of the factors can be properly represented by the category labels. Factor 1 is labeled "Technology Application Competencies (TAC)", as it largely contains items that relate to how technology can be applied, and for what purposes. Factor 2 is labeled "Information Processing Competencies (IPC)" as many of the items relate to seeking, evaluating, understanding, manipulating and presenting information. Factor 3 will be labeled "Understanding of the Workings of Technology (UWT)", as its items pertain mostly to understanding how certain technologies work.

3.1.4.3 Emergence to Group Level

When conducting multilevel research where an individual variable is theorized to impact a group level variable, it is necessary to demonstrate that there is enough agreement within each group to assume that there is a group-level phenomenon present (Kozlowski & Klein, 2000). Therefore, this next step involves the aggregation of the individual level variables, so that group level phenomena can be detected and their scores can be estimated. Here, group level phenomena that emerge are considered "shared knowledge" (Ployhart & Moliterno, 2011) among the group members. In this case, a

score for each of the three factors was generated by averaging each of the items assigned to the respective factor through the previous EFA, excluding missing values pairwise. To assess that a group-level construct has emerged, a sufficient amount of within-group agreement must be demonstrated. The ICC(1) and ICC(2) statistics are calculated using the method with SPSS version 23 (http://ibm.com/spss) described in Shrout and Fleiss (1979), and the within-group agreement (r(wg)) was calculated in Microsoft Excel 2013 using the method described by Bliese (2000). Table 3.3 (below) outlines the criteria in which the individual level data will be assessed.

Table 3.3: Statistics and criteria that are used to detect emergence of individual level factors to the group level.

Test	Acceptance Criteria
ICC1 (Shrout & Fleiss, 1979)	0.7 (Shrout & Fleiss, 1979; Kozlowski & Klein, 2000) Minimum of 0.06 has been accepted (Liao & Chuang, 2004)
ICC2 (Shrout & Fleiss, 1979)	0.7 (Shrout & Fleiss, 1979; Kozlowski & Klein, 2000) Minimum of 0.5 has been accepted (Liao & Chuang, 2004)
r(wg) (Bliese, 2000)	0.7 (Bliese, 2000; Kozlowski & Klein, 2000)

The results of this analysis are displayed in Table 3.4 (below). All average r(wg) exceeded the recommended threshold of 0.7 (Bliese, 2000). Minimum values for ICC(1) and ICC(2) of 0.06 and 0.5 respectively have been accepted for information systems research (Liao & Chuang, 2004), although the low and negative resulting ICC statistics for this research will need to be interpreted with care. As ICCs are calculated from the results of a one-way Analysis of Variance (ANOVA), a negative ICC can occur in some cases when the between-group agreement is greater than the within-group agreement. A large cluster size can contribute to negative bias to agreement, as can a large difference

among cluster sizes (Hox, 2002), and both conditions exist in this research. This research will follow the recommendation to interpret all conditions when aggregating data in multilevel studies (Dixon & Cunningham, 2009). The researchers considered that the dataset represents a diverse cross section of EMS services with varying cluster sizes (minimum=1, maximum=46 in this sample) as well as population sizes among different services (minimum=17, maximum=960; mean=195, standard deviation=217.8). Finally, a sufficient average r(wg) for all factors were reported. The decision is made that aggregation will proceed, although limitations herein are acknowledged. A summary of these results can be found in Table 3.4 (below).

Table 3.4: Emergence statistics.

Factor	ICC(1)	ICC(2)	Average r(wg)
TAC	0.03	0.11	0.73
IPC	-0.06	-0.26	0.72
UWT	0.09	0.28	0.78

3.1.4.4 Technology Application Competencies

Technology Application Competencies captures the proficiencies related to the ability to identify various applications of technology. Current evidence related to DCs in healthcare credits the individual's ability to appraise technology against current workflow in implementing new technologies, which in turn improves process outcomes (Davison & Hyland, 2002; Hyland et al., 2003; Singh et al., 2011). This implies that skills for identifying opportunities with technology contributes to processes associated with actually making changes to operational capabilities. At the organizational level, Sensing Capabilities imply that the organization is effective in finding information on

opportunities for change as well as the need for change in the environment (Teece, 2007; Pavlou & El Sawy, 2011). Indeed, environmental information comes into the organization via individual organizational members (Hargadon & Sutton, 1997), where it can then be appraised. In the marketing area, frontline staff are important to assess the needs of customers, and is linked to improved financial and innovative performance (Cadwallader et al., 2010). It is theorized that group-level TAC will impact Sensing Capabilities because an organization with more staff that have a higher ability to see where opportunities exist for improvement. Therefore:

> *H4a: Group-Level Technology Application Competencies will positively impact Sensing Capabilities.*

Learning Capabilities, referring to processes surrounding the application of new knowledge to existing processes (Pavlou & El Sawy, 2011; Zahra & George, 2002; Teece, 2007), will require the expertise of the front line employee. TAC seems to capture elements of knowledge of existing processes as well as technology, both of which are needed to adequately appraise a technology against a process (Davison & Hyland, 2002; Hyland et al., 2003; Singh et al., 2011). Therefore:

> *H4b: Group-Level Technology Application Competencies will positively impact Learning Capabilities.*

3.1.4.5 Information Processing Competencies

As discussed above, Sensing Capability includes routines pertaining to surveying the environment for opportunities (Teece, 2007). This can entail seeking for new technologies, potential areas for new service delivery models, and new health threats to the population. Detecting environmental phenomena may involve a degree of research for

the paramedics, as knowledge such as the emergence of opportunities or problems in the environment may need to be communicated to leadership or potential project sponsors, which the IPC factor seems to capture. Therefore:

> *H5a: Group-Level Information Processing Competencies will positively impact Sensing Capabilities.*

Learning Capability entails the development of knowledge as to how organizational resources can be configured to address the opportunity (Pavlou & El Sawy, 2011). The IPC factor captures the level of proficiency related to seeking and appraising information, basic research skills, and other related competencies. Assessing how environmental effects can be addressed within existing processes can entail effective research and reporting abilities, as it may require some external research as well as internal. Topics of this research could include current or projected performance or cost savings, results of external tests or pilot studies, for examples. Therefore:

> *H5b: Group-Level Information Processing Competencies will positively impact Learning Capabilities.*

3.1.4.6 Understanding of the Workings of Technology

The UWT factor captures some fundamental technical skills. This is likely important, as technical knowledge is necessary for the ability to recognize opportunities (Nonaka & Toyama, 2007), implying that this would be a precondition to the members of an organization understanding how new technological innovations in the environment work. Therefore:

> *H6a: Group-Level Understanding of the Workings of Technology will positively impact Sensing Capabilities.*

Organization-level capabilities related to integrating knowledge from among many organizational members may be assisted by paramedics with a higher understanding of technology. As a shared group level knowledge is an output of integrating capabilities (De Boer et al., 1999), pre-existing knowledge among the intended users regarding technology should assist in this process (Cohen & Levinthal, 1990). Therefore:

> *H6b: Group-Level Understanding of the Workings of Technology will positively impact Integrating Capabilities.*

With healthcare professionals, previous experience with technology is shown to have various attitudinal benefits that assist the implementation of technology and the associated changes (Ammenwerth et al., 2003; Dixon & Stewart, 2000). When tasks are assigned and labour is deployed, and technology is involved, understanding how technology works may reduce resistance to change among those using the new technology. Therefore, the following is theorized:

> *H6c: Group-Level Understanding of the Workings of Technology will positively impact Co-ordinating Capabilities.*

3.2 Conclusion

The purpose of this chapter is to present a theoretical model consisting of hypotheses that will be tested in this research. The hypotheses in this theoretical model support the first three research questions proposed in this research. This model is based on an integration of several theories that are employed in management, information systems and healthcare. First, the HIC model described by O'Carroll (2002) captures the knowledge and skills that healthcare workers have with using information technology on

the job, across a wide array of situations when organizations are undergoing technological or organizational change. Second, DCs (Teece, 2007; Teece et al., 1997) captures the organizational processes required for an organization to sense and react to changes in the external environment.

There are several features of note built into this theoretical model. First, DC is a higher order construct, comprised of four lower-order constructs: Sensing, Learning, Integrating and Co-ordinating. As per Cadogan & Lee (2013), the recommendation to hypothesize antecedents to the lower order constructs as opposed to the higher order construct is followed. Second, this model can be considered a multilevel model (Hox, 2002), as individual level competencies are hypothesized to impact organizational level capabilities. A related point, this chapter features an EFA, used in an *abductive* manner, to detect of phenomena within the HIC items (Haig, 2005b).

Chapter 4: Methodology

The purpose of this chapter is to describe in detail the methodology in this research. The first section of this chapter outlines the sequential explanatory mixed methods methodology (Creswell, 2009) approach used in this research, as well as the justification for employing this approach. The second section of this chapter describes the first phase of this research, which employs a quantitative approach, and the third section of this chapter describes Phase 2 of this research, which employs a qualitative approach, to take place after the completion of the first phase.

The first phase of this research supports the first three research questions: (RQ1) *Do the organizational abilities to reconfigure and integrate with other community partners influence the ability of the paramedic service to innovate?* (RQ2) *Do IT Service Provider related capabilities influence a paramedic service's ability to innovate?* and (RQ3) *Do the technology-related knowledge and skills possessed by paramedics influence the ability of their respective services to innovate?* In this section, the populations, samples, instruments, approach to data collection, analysis and assurance of reliability and validity used in this research are described in this chapter. As this is a multilevel model (Hox, 2002), there will be two related populations of interest in this research: Paramedic Leaders who represent the services that they lead, and the Paramedics who are employed by the service. Using the data collected, these hypotheses are tested using Partial Least Squares (PLS; Hair et al., 2013).

The second phase addresses the fourth research question (RQ4): *What factors are associated with paramedic services' ability to innovate?* The section describing the second phase details the measures taken when selecting participants, conducting in-depth interviews, and analyzing the qualitative data from the second phase. The research will conclude with a mixing stage, where the results from the first and second phase will be interpreted together, and will answer the fifth research question (RQ5): *How do the quantitative and qualitative data together reveal approaches to improving the ability of a paramedic service to innovate?*

4.1 Methodological Approach

This research employs a sequential explanatory mixed-methods approach (Creswell, 2009; Johnson et al., 2007; Tashakkori & Teddlie, 2010). Two phases comprise this research, described in detail below. The first quantitative phase involves the assessment of HICs in a sample of Canadian paramedics (the results of which, presented in Chapter 3, were used to assist in the construction of the theoretical model). As well, data for the measurement of organizational-level variables are sought from Canadian Paramedic Leaders. As this is a multilevel model (Raudenbush & Bryk, 2002; Snijders & Bosker, 1999), the paramedics are considered to be individual-level participants, and Paramedic Leaders are considered group-level participants. All data are collected through two online questionnaires, one designed for the Paramedic Leader and one designed for the Paramedic. The second qualitative phase elicits both facilitating and inhibiting factors affecting ways in which paramedic services innovate, with respect to organizational

context, individual contribution, the role of technology, and other themes. First phase participants will be selected for participation in the second phase based on their level of SIP, and assigned to a high-performing group and a low-performing group. See Figure 4.1 (below) for a process diagram outlining the sequence of steps taken in this research.

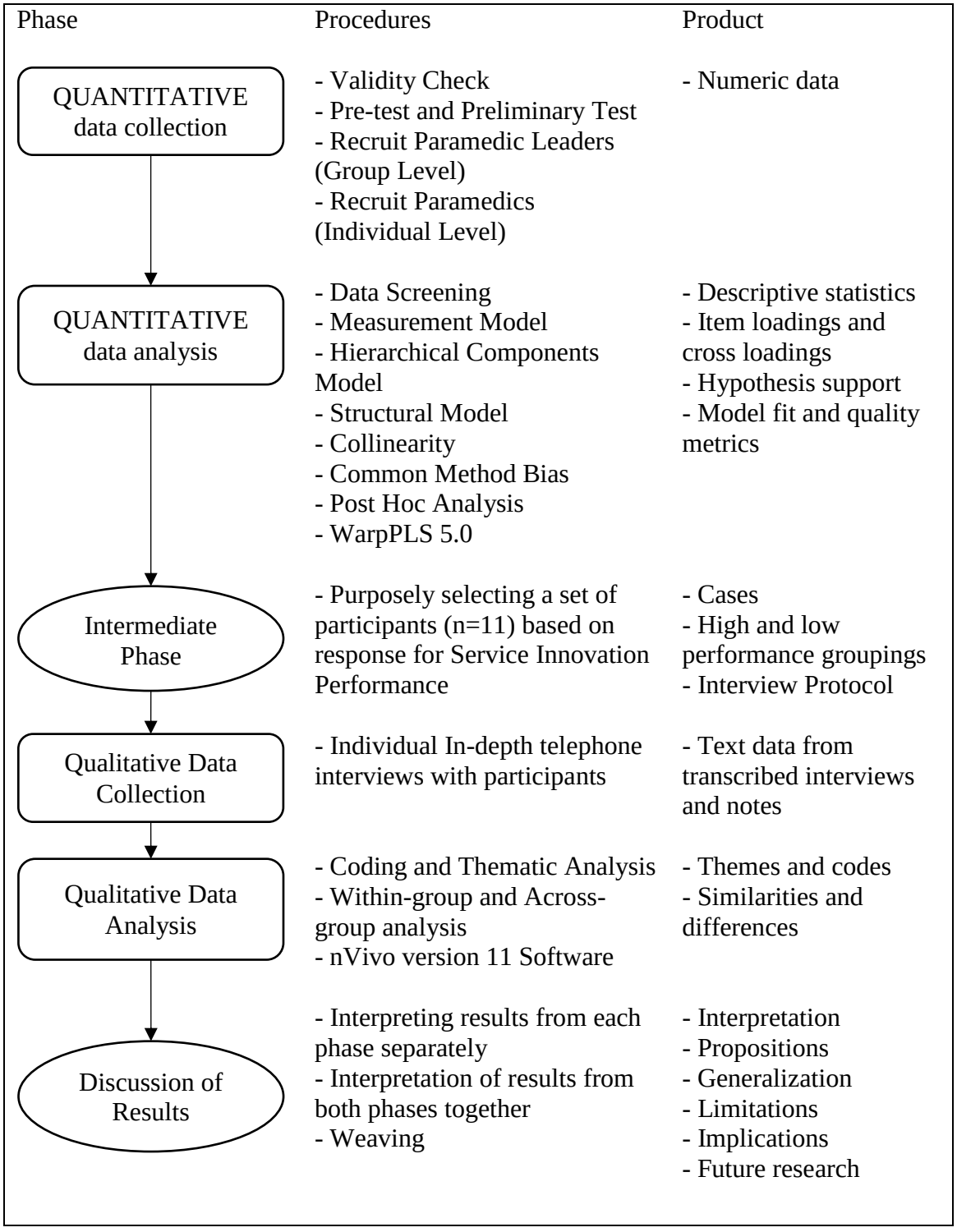

Figure 4.1: Phases in this mixed-methods sequential explanatory study.

4.1.1 Justification for the Use of Sequential Explanatory Mixed Methods Approach

The sequential explanatory mixed methods methodology is justified in this case, for the following reasons. As articulated in this the introduction, the context of paramedicine is undergoing a rapid and dramatic change, largely driven by new technology, more integration, and a shortage of emergency medical resource capacity. Despite this, there is a notable lack of research on innovation in paramedicine, the use of technology in paramedicine, and other subjects that this research will cover. By using this methodology, it is the intent of the researchers to develop a richer result than quantitative or qualitative methods alone. This method will produce more informed theory and research questions as an output, than otherwise would have been developed by two studies separately under different projects.

Although several approaches to mixed methods research exist, the sequential explanatory mixed methods approach as described above is specifically chosen, as it best meets the research gaps as articulated. Other mainstream approaches include sequential exploratory, characterized by a qualitative phase followed by a quantitative phase, with the first qualitative phase emphasized (Creswell & Plano Clark, 2011). This method is best suited towards the generation and validation of an instrument within one study. This approach will not address the research gaps for this study for a few reasons. Although an instrument that measures informatics competencies of paramedics may be useful, its utility would be maximized if the study was at a national level, with the goal of augmenting the National Occupational Competency Profile for Paramedics (NOCP; See

Section 7.5 (Managerial Implications), below). This study is a low-resource study, with only a limited partnership with some paramedic services and paramedic leadership associations. Therefore it may be a futile effort to develop such an instrument before the context and need for it is established, making the sequential exploratory approach inappropriate for this study.

Another approach is the concurrent approach, which involves collection and analysis of quantitative and qualitative data at the same time from typically different samples, with a data mixing phase typically occurring at the end (Creswell & Plano Clark, 2011). The main advantage of this approach is that it combines the strengths of both quantitative and qualitative approaches, and is suitable for producing a robust research output. In this case, the concurrent approach is not sufficient to address the research gaps, as it will not give insight as to what organizational practices best lead to service innovation. The reason for this rests in the use of an intermediate phase (described above), where cases will be identified and chosen for qualitative follow-up base on their level of service innovation performance. Such a phase will allow the researcher to ensure that both high and low innovators are chosen, and the subsequent identification of practices that lead to high innovation performance, and the barriers experienced by low innovation services. Such a result may indeed be uncovered with a concurrent approach, although it lacks this stated purpose, as well as the design feature to accomplish this.

4.2 First Phase - Quantitative Data Collection

The purpose of this phase is to test the hypotheses in the theoretical model presented in Chapter 3. This phase uses a quantitative approach, and is the first phase in a two-phase sequential explanatory mixed methods approach.

4.2.1 Paramedic Leader Population, Recruitment and Sampling

The Paramedic Leader population is defined as those that are currently in leadership positions at Canadian land-based paramedic services (air ambulance services are excluded). These include paramedic chiefs, deputy chiefs, executive directors, owner/operators, or other equivalents. Several sample frames were accessed in national and provincial professional organizations. Participants were self-selected, that is, they volunteered. The research was restricted to participants who are capable of communicating in English. Prior to acceptance into the study, participants were screened based on the criteria described above. Paramedic Leader participants must be willing to recruit paramedics for the study in their respective paramedic services. Paramedic Leaders that agreed to participate were asked to refer other potential participant Paramedic Leaders. Paramedic Leaders were asked if they wished to participate in future phases of the study. With the assistance of G*Power (Faul et al., 2007), a power calculation reveals a minimum of 43 participating paramedic services are needed, with the ability to detect a large (0.35) effect size, statistical power level of 0.8, and probability level of 0.05. This is an achievable sample size, as Ontario alone has over 50 paramedic services.

4.2.2 Paramedic Population Recruitment and Sampling

The paramedic population is defined as paramedics who are currently employed at a Canadian land-based paramedic service. The sample frame is defined as paramedics employed by paramedic services where the Paramedic Leaders have agreed to participate. Paramedics were recruited through the regular communication channels at these services, such as message boards, email lists, posters and listservs. Recommendations developed from Monte Carlo testing suggest that at least 5 respondents from each service responding to the questionnaire would be sufficient (Maas & Hox, 2005), but a limited number of smaller clusters with even one respondent per group can be tolerated (Bell et al., 2008). Paramedics had the option to enter their names into a draw for one $500 prize per 500 entrants.

4.2.3 Instruments and Scales

The quantitative data were collected with an online questionnaire to be filled out by the participants. There were separate questionnaires for Paramedic Leaders and Paramedics. Questionnaire items were adapted from various existing and validated instruments. For Paramedic Leaders, the questionnaire contained items adapted from the previously validated Pavlou & El Sawy (2011), Narasimhan & Kim (2002), and Kim et al. (2011). As per Bhatt et al. (2010), a scale was constructed for Relationship Infrastructure, based on Ross et al. (1996). For Paramedics, the questionnaire contains items adapted from O'Carroll (2002), containing the HIC self-report items, grouped by the resultant factors that were the outcome of the abductive use of EFA, as detailed in

Chapter 3. Control variables for Paramedic Leaders include Title, Gender, Years in Position, EMS Service, Province, Paramedic Count, Funding for CP activities, and Funding for Technology. Control variables for paramedics were Rank, Years Experience, and Gender. Examples of these items are shown (below) and Tables 4.1 and 4.2 (both below) and the entire instruments are shown in Appendix A – Paramedic Instrument and Recruiting Material and Appendix C – Paramedic Leader Instrument and Recruitment Material.

Table 4.1: Sample items for the Paramedic Leader questionnaire.

Construct	**Sample Item**
Sensing Capabilities (Pavlou & El Sawy, 2011)	We periodically review the likely effect of changes in our service delivery model on patients
Learning Capabilities (Pavlou & El Sawy, 2011)	We have adequate routines to assimilate new information and knowledge.
Integrating Capabilities (Pavlou & El Sawy, 2011)	We are fully aware who in the group has specialized skills and knowledge relevant to our work.
Coordinating Capabilities (Pavlou & El Sawy, 2011)	We ensure an appropriate allocation of resources (e.g., information, time, reports) within our group.
Service Innovation Performance (Menor & Roth, 2007)	As compared to other paramedic services, what is the level of your services' innovation efforts in meeting citizens' needs?
Integration (Narasimhan & Kim, 2002)	Have a high degree of joint planning with other organizations (i.e. healthcare, social services).
Relationship Infrastructure (Bhatt et al., 2010; Ross et al., 1996)	When setting strategy, I consult with those responsible for the management of our IT resources.
IT Business Expertise (Kim et al., 2010)	Our IT personnel understand our organization's policies and plans at a very high level.

Table 4.2: Sample items for the paramedic questionnaire.

Factor	**Sample Item**
TAC	Utilize modern information technology as a tool to promote public health
IPC	Identify information sources that are potentially relevant to public health
UWT	Use the media, advanced technologies, and community networks to communicate

4.2.4 Validity

In quantitative research, validity, or specifically measurement validity, is the quality of an instrument to accurately measure the concept that it purports to measure (Creswell, 2009). Steps taken during the refinement of the instrument can be used to strengthen two types of validity: *face* and *content* validity. Face validity refers to the judgment by the scientific community that an indicator indeed measures the construct that it intends to. Content validity assures that the entirety of the conceptual definition is represented in the indicators that measure that concept. Face validity of the constructs was strengthened by ensuring that each questionnaire item could correctly be matched to its intended construct. They also evaluated each item for ambiguities and items that contain more than one idea (Creswell, 2009). All items were correctly matched to their respective constructs by this process. To strengthen content validity, two academics (one in the Strategic Management area, and one from the Information Systems area) inspected the construct definitions to ensure that the definitions of all constructs were adequate before the items were pre-tested. Two types of validity can be verified and refined during analysis of the data (*convergent* and *discriminant* (sometimes called *divergent*) validity), and are therefore explained in the Measurement Model Estimation section (below).

4.2.5 Common Method Bias

Common method bias, one of the main sources of measurement error, occurs when some of the error that exists between true and observed scores can be attributed to the measurement method (Podsakoff et al., 2003). The amount of this error that can be attributed to non-random forces such as measurement method is referred to as systematic measurement error (Bagozzi & Yi, 1991). It should be the objective of the researcher to reduce this source of error, as its presence will hinder the ability to estimate a true score of a measure and to therefore make correct inferences regarding the support for hypotheses (Campbell & Fiske, 1959). There are a few potential sources of systematic measurement error relevant to this research, which can be attributed to the participant, the individual items, or the entire measurement model (Podsakoff et al., 2003). Other sources of such errors include: the desire of participants to appear rational and consistent; the desire to answer in a way that they feel their peers would want them to; and the transient mood of the participant at the time they are participating in the questionnaire (Podsakoff et al., 2003). Items that contain ambiguities, inappropriate jargon, biased, or double meanings may influence participants to judge the items in a non-consistent manner. Finally, the time and place of measurement, as well as any emotional reactions felt by the respondents may influence their responses.

Several actions were taken in this research to reduce these systematic sources of error. First, all items were presented to the respondents in a random manner, where no one participant received the items in the same order. Second, as described above, the

questionnaires were vetted for ambiguous items and other confusing language by academics and field practitioners. Finally, during the analysis of the data, the Full Collinearity VIFs will be inspected, and scores less than 3.3 suggest that common method bias is not present (Kock & Lynn, 2012).

4.2.6 Preliminary and Pre-Test phases

The preliminary phase involved two Paramedic Leaders (one from Ontario and one from Alberta) and four paramedics (two from Ontario and two from Alberta) to ensure the instruments were suited for their intended population by adapting wordings, adding or removing items based on relevance, and testing the questionnaires for the same reasons. The Paramedic Leaders reviewed the entire process of collecting data from their respective services. First, they reviewed the cover letters, instructions and instruments and offered word changes to ensure better understanding among Paramedic Leaders. They then completed the questionnaire. They then asked two of their Paramedics to review and complete the instruments, offering no feedback. No technical issues were found in this process. After this successful pretest, ethics clearance was obtained through the McMaster University Research Ethics Board in November 2014 (See Appendix D – McMaster University REB Documentation), and was then widely deployed. During deployment, AHS required a research agreement with the researchers (See Appendix E – AHS Research Agreement). Southern Health, a Manitoba Regional Health Authority (RHA), required their own ethics approval (See Appendix F – Southern Health (MB) Ethics Approval)

4.3 Quantitative Data Analysis

Analyzing the quantitative data involved the following steps. First, the dataset was assessed for invalid responses, and response bias in both cases and individual items. This included visual assessment of the dataset itself as well as several boxplots and histograms. No records were detected where gaming was suspected.

4.3.1 Partial Least Squares and WarpPLS

PLS (Hair et al., 2011; Hair et al., 2013; Wold, 1966; Chin, 1998b) was used to assess the quality of the overall model viability of the hypotheses. PLS is a form of Structural Equation Modelling (SEM: Hair et al., 2011) and has been shown to perform better in studies with smaller sample sizes as well as being able to include both formative and reflective variables in the model (Fornell & Bookstein, 1982; Hair et al., 2011). As well, it is a tool that is valuable when the goal of the research is to develop theory, rather than confirm it (Wold, 1980). PLS is more tolerant when datasets contain single item latent variables, or latent variables with as few as two items (Hair et al., 2011). It is widely used in information systems research (Ringle et al., 2012).

More specifically, WarpPLS (Kock, 2015) was used, as it has the ability to detect non-linear relationships between single item variables and latent variables. Analysis of the dataset using multiple linear regression in SPSS version 23 (http://ibm.com/spss) and PLS with SmartPLS 3 (http://smartpls.de) resulted in very few of the hypotheses being supported. The presence of non-linear relationships was confirmed when the hypotheses were tested specifically with the PLS Mode M algorithm in WarpPLS. This algorithm

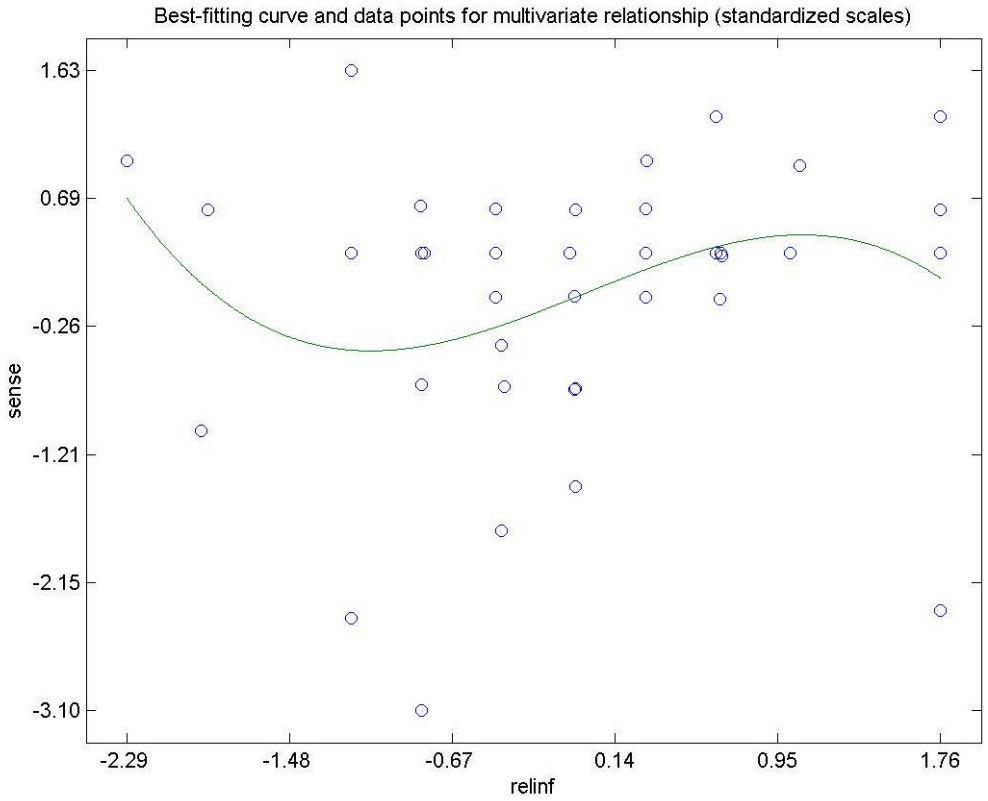

Figure 4.2: Example of a warped, or non-linear, relationship in WarpPLS, illustrating an "S" curve.

will calculate a "composite score" for estimation of the latent variable that is necessary when testing relationships between lower order constructs and antecedent latent variables (Cadogan & Lee, 2013). The Warp3 (Kock, 2015) algorithm was used for the analysis of the outer model. This algorithm attempts to fit each tested relationship into an "S"-shaped curve, different from the "Linear" and "Warp2" algorithms, which attempt to fit the data to a linear and "U"-shaped curve, respectively. The way that WarpPLS specifically fits the regression relationships between latent variables to a curve is to apply a function (such as a logarithmic function) to the data, as is commonly done in a manual fashion

elsewhere (Kock, 2010). Figure 4.2 (above) is an example of a non-linear relationship that can be estimated in WarpPLS.

4.3.2 Measurement Model Estimation

The measurement model is assessed to determine how each item relates to its latent variable (Chin, 1998b). Generally, assessing the measurement model (sometimes referred to as the inner model) involves the confirmation of *convergent* and *discriminant* validity, two types of validity related to how the measured items relate to their assigned latent variables (Chin, 2010), as well as internal consistency of the constructs. The process in which these three criteria are confirmed and improved often involve the removal of several measurement items from the model.

Convergent validity refers to the degree that an item loads onto its parent construct (Creswell, 2009). Several criteria can be used to evaluate convergent validity. Item loadings must be greater than 0.708, or greater than 0.4 if their deletion improves Average Variance Extracted (AVE) and Composite Reliability (Hair et al., 2011). As well, for each construct, AVE should be greater than 0.5 (Hair et al., 2013; Fornell & Larcker, 1981).

Discriminant validity refers to the degree that an item does *not* cross-load, or in other words, does *not* load highly onto constructs other than its parent construct (Creswell, 2009). To evaluate discriminant validity, item cross-loadings must be lower than its item loading (Hair et al., 2011). As well, the Square Root of the AVE of a construct should be greater than correlations with all other constructs, referred to as the

Fornell & Larcker (1981) test. Finally, correlations among the variables should not be greater than 0.71 (Andreev et al., 2009).

Internal consistency reliability refers to the ability of a different items on a measure to produce similar scores (Pedhazur, 1991). To assess internal consistency reliability, Cronbach's (1951) alpha needs to be at least 0.7 (Nunnally, 1978), and the Composite Reliability must be at least 0.6 (Hair et al., 2011; Bagozzi & Yi, 1991). Table 4.3 (below) presents the techniques and evaluation criteria that will be used to assess convergent and discriminant validity and internal consistency, which largely follows the process in Hair et al. (2013).

Table 4.3: Measurement Model Evaluation Criteria

Analysis	**Test**	**Acceptance Criteria**
Convergent Validity	Item Loadings	Indicator weight should be greater than 0.708. Indicators less than 0.4 should be deleted. Indicators with weights between 0.4 and 0.7 should be deleted only if it improves AVE and Composite Reliability (Hair et al., 2011)
	AVE	Greater than 0.5 for each construct (Hair et al., 2013; Fornell & Larcker, 1981).
Discriminant Validity	Cross-loadings	Indicator Loadings should be greater than all its cross loadings (Hair et al., 2011)
		Fornell Larcker test – Square Root of AVE should be greater than correlations with all other constructs (Fornell & Larcker, 1981)
		Correlations of latent variables should be below 0.71 (Andreev et al., 2009)
Internal Consistency Reliability	Cronbach's Alpha	Greater than 0.7 (Nunnally, 1978)
	Composite Reliability	Greater than 0.6 (Hair et al., 2011; Bagozzi & Yi, 1991)

4.3.2.1 Hierarchical Component Model

A hierarchical components model is used to assess DCs. Sensing, Learning, Integrating and Co-ordinating Capabilities are therefore considered lower order constructs, and Dynamic Capabilities is considered the higher order construct. This modeling is referred to as "Type II" or "Reflective-Formative" (Becker et al., 2012; Chin, 1998a), where the lower order constructs are modelled as reflective variables, and the higher order component is a formative variable. To estimate DCs and its lower order constructs, the two-stage (Wetzels et al., 2009; Ringle et al., 2012) method was chosen. First, the latent variable scores for each of the lower order constructs (sense, learn, integrate and coordinate) are computed. Second, these latent variable scores are added to the higher order construct as reflective indicators. After this process, the structural model estimation follows.

4.3.3 Structural Model Estimation

Next, the structural model (also known as the outer model) was assessed, and the support for the hypotheses presented in Chapter 3 will be revealed by examining their respective significance levels and path coefficients (Chin 2010). Goodness of fit indices commonly used to evaluate the quality of SEM models don't apply to PLS (Henseler & Sarstedt, 2013). There are however several indices commonly used to assess quality. These include Average Path Coefficient (APC), Average R^2 (ARS), Average Adjusted R^2 (AARS), Average Block VIF (ABVIF), and Average Full Collinearity VIF (AFCVIF), which should be below 5 or 3.3 (Kock, 2015). Since a higher order construct is used in

this model, the AVCVIF will be artificially inflated (van Reijsen et al., 2015). Therefore, evaluation of the AVCVIF measure is generated through an alternative model with no hierarchical constructs. Table 4.4 (below) outlines the criteria that are used on each step of evaluating the structural model, largely following the process set out in (Hair et al., 2013).

Table 4.4: Structural Model Estimation Evaluation Criteria

Analysis	**Test**	**Criteria**
Structural Paths	Significance	Below 0.05
	Path Coefficient	
Goodness of Fit	APC, ARS, AARS, ABVIF, AFCVIF	5 or 3.3
Coefficient of Determination	R^2	> 0.75 = substantial > 0.5 = moderate > 0.25 = weak (Hair et al., 2011)
Effect Size	f^2	0.02 = small 0.15 = medium 0.35 = large (Cohen, 1988)
Predictive Relevance	Q^2	Greater than 0 (Stone, 1974; Geisser, 1974)

4.3.4 Collinearity

Collinearity (sometimes referred to as *multicollinearity*) exists when two predictor latent variables correlate to a high degree, making it difficult to assess which variable is having an impact on a criterion, or even in determining if these two variables are in fact measuring the same phenomenon (Hair et al., 2011). Collinearity can be detected by inspecting the block Variance Inflation Factors (VIFs). VIFs below 5.0 are sufficient to assume that collinearity is not present (Hair et al., 2013).

4.3.5 Alternative Model Evaluation and Post Hoc Analysis

Finally, several alternative models were compared, and some post-hoc analysis undertaken to explore the data further. For the alternative models, the Goodness of Fit tests outlined in Table 4.4 (above) as well as the Tenenhaus (Tenenhaus et al., 2005) Goodness of Fit (GoF) were used to compare the models with each other.

4.4 Second Phase – Qualitative

The second qualitative phase investigates the determinant themes, contextual, individual and otherwise, regarding the facilitators and inhibitors of innovation. This phase answers the fourth research question (RQ4: "*What factors are associated with paramedic services' ability to innovate?*"). The outcomes of this phase are used to refine the theoretical model presented in Chapter 3. In-depth interviews with select Paramedic Leaders from the first phase are used in this phase. Participants in this phase were purposefully selected based on their scores on the SIP items. Based on these items, they were placed in one of two groups reflecting the intensity in which they have answered on these scores. Approximately 10 interviews took place, or enough to note that saturation was reached (i. e. newer participants were not adding further knowledge to the results) (Lee, 1999).

The interview protocol consisted of scripts, open-ended questions, general questions and probes to ensure sufficient elaboration on the themes being explored (Creswell, 2009; Bachiochi & Weiner, 2004). Most questions were focused on different important aspects of innovation that have been identified in the literature. As innovation

can be impacted by many factors other than technology, a broad approach in this phase is taken, to ensure that important factors are captured in these interviews, and subsequently guide the creation of the interview guide for this second phase. These factors include: organizational culture (Büschgens et al., 2013); technology (Page, 2014); relevance of frontline staff skills (Ottenbacher & Harrington, 2010); leadership and authority (eg. Drotz & Poksinska, 2014); policy (Page, 2014); and external partners (West & Bogers, 2014).

The interviews were scheduled with participants via email, and conducted over the telephone, as participants were located across Canada. Interviews were audio recorded with explicit consent of the participant, and then transcribed to text. The interviewer's notes and a transcript of the phone call were compared before being subjected to analysis. This phase required a separate consent form for participants, and the protocol was cleared by the McMaster University Research Ethics Board (REB) (See Appendix G – Paramedic Leader Second Phase Interview and Recruitment Material and Appendix H – McMaster University REB Documentation for Second Phase).

4.4.1 Qualitative Data Analysis

The thematic analysis (Braun & Clarke, 2008) approach was adapted to analyze the data from the in-depth interviews. The outcome of this approach is a rich description of themes that are relevant in answering the research question. Themes are defined as "something important" in relation to the research question, which emerge from the qualitative data in some sort of pattern and level of prevalence (Braun & Clarke, 2008). A

broad view of innovation is therefore subscribed to, in order to capture any concept that is associated with the ability of a paramedic service to innovate, or lack thereof. Therefore, this is intentionally designed to capture any concept that is relevant to innovation, and is not limited to those related to technology.

There are six phases necessary in order to perform thematic analysis (Braun & Clarke, 2008): 1) becoming familiar with the data, 2) generating a set of initial codes, 3) searching for themes, 4) reviewing the themes, 5) defining and naming the themes, and 6) producing the report. First, becoming familiar with the data involves transcribing the data, reading it several times, and taking note of general ideas. It is important in this first phase for the researcher to examine and reflect on the data with the intent to seek out patterns and deeper meanings within the material, as well as take notes of these thoughts. Next, an initial set of codes are generated as the researcher seeks to identify important features in the data. These features can either be semantic or latent, meaning that themes can either be based on explicit terms from the participants, or based on the deeper meanings, underlying assumptions and interpretations (Boyatzis, 1998).

The third step involves taking the initial set of codes, and sorting and collating them to generate an initial list of themes (Braun & Clarke, 2008). The fourth phase is a refinement in the themes, where themes may be combined, added, split or eliminated. Internal homogeneity and external heterogeneity were sought to ensure that the themes were coherent yet distinct from one another (Patton, 1990). To accomplish this, the coded excerpts for each theme were inspected, to ensure that a coherent pattern was formed

from all codes within the theme. Following that, the validity of the themes was considered in the context of the entire dataset, to ensure that they make sense. It is important to consider that this process should stop when a "satisfactory" solution is reached, as analysis could go on for an excessive period of time in search of an unattainable "perfect" solution.

The fifth phase involved proposing definitions for the newly refined themes, that captures the importance and meaning of the theme, as well as how these themes relate to each other, and fit into an overall broad *story* that can describe the context. Any sub-themes were described as well. Care was taken to not make the definitions too complex or encompassing, or to make them overlap with one another. Finally, the sixth phase involved producing the final report, providing an interesting, convincing, and appropriately detailed story that explains the data, and at the same time, producing enough evidence in the form of data extracts.

4.4.2 Coding Frame

For an initial coding frame, factors were organized along two dimensions, resulting in a matrix of four factors: paramedic level and organization level factors; and inhibitors and facilitators for each of those dimensions. This coding frame was selected as it reflects the two units of analysis in the quantitative phases, and therefore can more readily be enhanced by the results of this phase. Specifically, the discovery of both paramedic and organizational factors can guide academics and practitioners as to what phenomena are important for innovation in both healthcare and paramedicine. These

factors can guide the development of new theory, as well as provide direction for Paramedic Leaders and healthcare system administrators.

4.4.3 Reliability

When referring to qualitative studies, reliability has different connotations than it does in quantitative research, although both are based on the ability of a measure to remain consistent among raters. In the case of quantitative research, raters refer to the participants in the research, and the measure refers to the instrument and its items. However, in qualitative research, raters refer to the researchers who extract codes from the data, and reliability is a measure of the agreement between the researchers on the codes that they extract (Miles & Huberman, 1994). This is referred to as inter-rater reliability, or intercoder agreement (Miles & Huberman, 1994; Creswell & Plano Clark, 2011). In this research, a second rater was used to validate the codes generated by the first rater. Agreement was reported by using percentage agreement, as well as Cohen's Kappa (Cohen, 1968; Cohen, 1960). Using the Kappa statistic to determine interrater agreement that is appropriate when there are two raters, and is more robust than a simple percentage of agreement, as it considers also agreement by random chance. Kappa statistics are between 0 (no agreement) and 1 (perfect agreement), and a liberal criterion of 0.7 as recommended by Frey, Botan, & Kreps (2000) will be used to determine the inclusion of a theme, as this is small scale research.

4.4.4 Role of the Researcher

As recommended by Creswell (2009), researchers should declare their biases, values, and other applicable information in advance, as these will be used to shape the resulting interpretations of the qualitative phase. The researcher, an experienced technologist and not a clinician, has previously participated in two 12-hour overnight ride-alongs with paramedics from Superior North EMS in Thunder Bay, Ontario. On these ride-alongs, the researcher had an opportunity to observe paramedics as they performed their jobs, to assist in some light duties, to observe their use of technology and documentation, and to ask them their attitudes and opinions on the use of technology and innovation on the job. As well, the researcher conducted several studies in paramedicine, mostly concerning accuracy in determining dispatch priorities (Dohan et al., 2013; Dohan et al., 2014). During this project, the researchers interacted with Paramedic Leaders and Paramedics concerning the impacts, prevalence and nature of dispatch over-prioritization in Ontario. As well, discussion with Paramedic Leaders concerned other issues that broadly affect paramedicine, such as contextual factors that are relevant to innovation. Finally, the investigator interacted closely with Paramedic Leaders as part of a preliminary investigation of the topic and while attending Paramedic Leader conferences.

4.5 Anticipated Ethical Issues in the Study

This study is considered one of low risk. As previously mentioned, this project and its ethical considerations were approved by the McMaster University REB. All paramedics in the first phase were anonymous, and confidentiality was promised to the

Paramedic Leaders. As well, Paramedics were able to submit their email addresses if they wanted to be included in the prize draw. In this case, the emails were not attached to any of the answers given by the participants. After its analysis, data were archived in a secure offline location on the McMaster University campus until 10 years after the completion of this study. All participants were given the option to withdraw from the study, and there was no consequence for withdrawing. Paramedic Leaders were given the opportunity to withdraw before they submitted their answers to the study by simply abandoning their responses. After a response was submitted, Paramedic Leaders could have had their responses destroyed, by requesting this of the investigator. Paramedic responses were not identifiable after they were submitted, so they couldn't have been destroyed after the participant submitted them. In both cases, the email addresses were destroyed after completion of the second phase of the research and the prize draw for $500 was awarded.

4.6 Conclusion

The purpose of this chapter is to describe the methodology used in this research. This research employs a sequential explanatory mixed methods methodology (Creswell & Plano Clark, 2011), which involves a quantitative phase followed by a qualitative phase. The quantitative first phase was used to evaluate the theoretical model presented in the Chapter 3. This model was evaluated with PLS (Hair et al., 2011). The second, qualitative phase was used to construct an in-depth, rich understanding of innovation with respect to paramedic services, for informing the theoretical model proposed in Chapter 3.

Chapter 5: Results – Quantitative Phase

The purpose of this chapter is to describe the collection, assessment and analysis of the quantitative data, in order to evaluate the theoretical model presented in Chapter 3. In doing so, it is supporting the first three research questions proposed in this dissertation: (RQ1) *Do the organizational abilities to reconfigure and integrate with other community partners influence the ability of the paramedic service to innovate?* (RQ2) *Do IT Service Provider related capabilities influence a paramedic service's ability to innovate?* and (RQ3) *Do the technology-related knowledge and skills possessed by paramedics influence the ability of their respective services to innovate?*

Data collection took place from November 2014 to April 2016, and the finalized dataset contains ratings for the HIC items from 502 paramedics from 43 services. Response rate was estimated 30.3% of the number of services contacted and 9.0% of the number of paramedics reached. The results show support for 6 of the 11 hypotheses that were antecedent to the four dimensions of DCs (Sensing, Learning, Integrating and Co-ordinating Capabilities) as well as the DCs that were a determinant of SIP.

5.1 Data Collection

Data collection took place between November 2014 to April 2016. As this was a national level study, recruitment methods were adapted to reflect local nuances among different provinces and territories. In Ontario, recruitment was aided by the Ontario Association of Paramedic Chiefs (OAPC), and a support letter from the president was obtained for this research (See Appendix I – Support Letter from OAPC). Ontario

Paramedic Leaders were solicited through email sent by a representative from the OAPC, as well as contacted via telephone through contact information publicly available at http://emsontario.ca. In Manitoba, support for recruitment was received from the Emergency Medical Services branch at Manitoba Health, Seniors and Active Living, a department of the Government of Manitoba. One Manitoba RHA required their own ethics approval, and required a version of the survey where no compensation could be made available to paramedics. Another Manitoba RHA requested paper surveys be made available to their paramedics. Both of these changes have been approved by McMaster University REB (See Appendix D - McMaster University REB Documentation). In Saskatchewan, the Saskatchewan Emergency Medical Services Association (SEMSA), a governing body for paramedic services in that province, contacted Paramedic Leaders with a recruitment email that was crafted by the researcher. As well, the Saskatchewan College of Paramedics approved this study. In Alberta, a research agreement for this project was obtained from AHS. The study was permitted by the Department of Health and Community Services of Newfoundland and Labrador, and some publicly available contact information was provided by this department. Permission was obtained to collect data from one service in one territory (blinded). The researchers attempted to obtain permission from relevant authorities in Prince Edward Island and British Columbia, but were refused. The process to acquire permission to conduct research in Nova Scotia was prohibitive, given the resources allocated for this project. Permission was also attempted

in New Brunswick, Quebec and the other two blinded territories, and these efforts were not fruitful.

5.1.1 Response Rate

In total, it is estimated that 188 services were contacted by the researcher: 1 in British Columbia; 5 in Alberta; 4 among the three territories; 104 in Saskatchewan; 5 in Manitoba; 61 in Ontario, 1 in Nova Scotia; 1 in New Brunswick; 4 in Newfoundland and Labrador; 1 in Prince Edward Island, and 1 in Quebec. The manner in which paramedic services are administered across Canada varies widely from province to province; some provinces have one service provincially/territorially (as is the case in British Columbia and Nova Scotia, for example), others are operated by a health region or regional health authority (as is the case in Alberta, most of Manitoba and Newfoundland and Labrador), some are operated by a municipality such as a city or county (as is the case in Ontario). Saskatchewan uses a mix of private operators and health regions, which were both considered services under this study. Both Saskatchewan and Ontario have instances where a private paramedic service provider contracts their services out to a governmental body.

Of the 188 services that were contacted, 64 Paramedic Leaders attempted to start the survey, and 60 completed it. If there was more than one response received from any particular service, all but the response with the highest ranked participant were discarded, as only one Paramedic Leader response per service is needed. The identity of one Paramedic Leader participant could not be verified, and 6 redundant responses were

found, leaving 53 Paramedic Leaders representing 53 services. This accounts for a response rate of 30.3% (57/188). Of these, 6 did not complete the paramedic recruitment portion of the study, and one Paramedic Leader contacted the investigator to abandon the study. 4 of the Paramedic Leader responses were eliminated because less than 15% of the questions were answered, regardless if they had recruited paramedics or not. The final number of Paramedic Leaders included in the study was 43, satisfying the sample requirements determined from the power calculation (see Chapter 4). Based on responses from Paramedic Leaders, it is estimated that these 43 services represent approximately 8270 paramedics. Before the data from the two Manitoba sites requiring local adaptation were included in the main sample, an ANOVA analysis was used to detect if there were any significant differences between these two sites and the main sample. Seeing no significant differences between groups for any of the variables, they were brought into the main sample.

In most cases, the paramedic portion of the study was considered complete if at least 5 paramedics from each responded to the study, but this was relaxed in smaller services where 10% of the number of paramedics was 5 or less. Speaking to the variability in size of services in the sample, the smallest service in this study employs 17 paramedics, and the largest employs 960 paramedics, with a standard deviation of over 200 and a median of 112.5. For the paramedic instrument, 746 initiated the questionnaire, resulting in an approximate 9.0% (746/~8270) response rate from paramedics. 540 completed it, and 38 were deleted as more than 15% of the questions were blank,

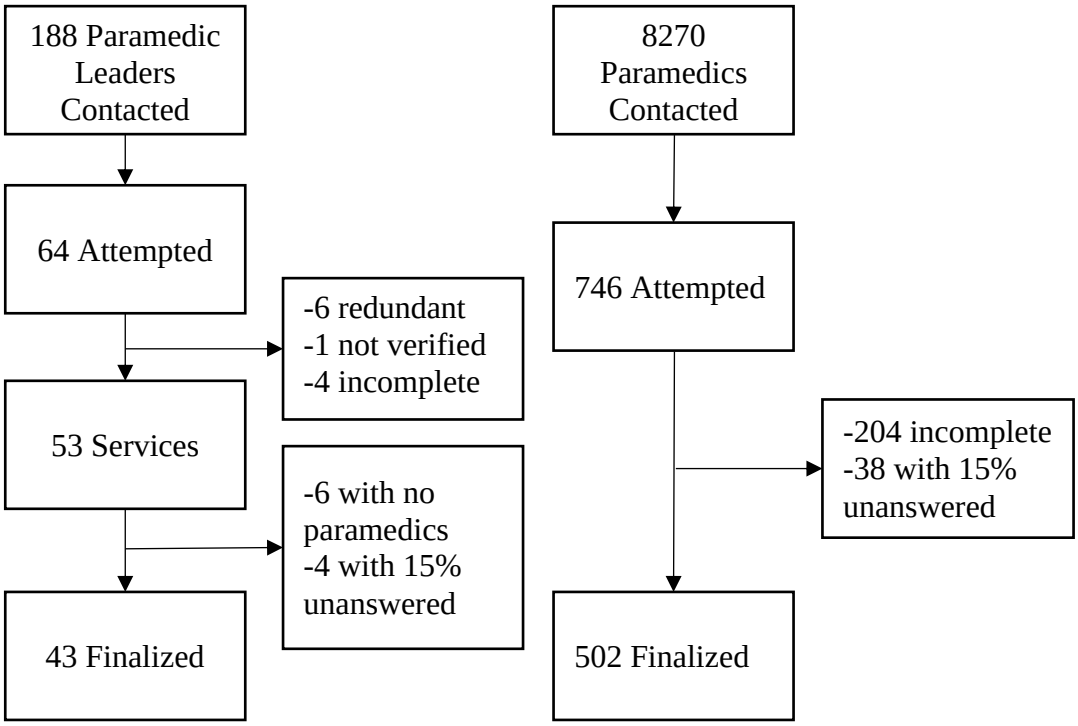

Figure 5.1: Flow diagram for recruitment for this research.

resulting in a final sample of 502 paramedics. This study also accepted a low number of singletons (i.e. groups with only one respondent), as a low number can be tolerated without degrading ability to detect effects (Bell et al., 2008). This is a necessity for this project, considering the natural variation in populations between large cities and sparsely populated rural areas. Figure 5.1 (above) depicts a flow diagram for study recruitment.

5.1.2 Descriptive Statistics

Table 5.1 (below) shows a description of the individual and group level samples. Out of the 43 Paramedic Leader (group-level) participants, 24 (55.8%) were from Ontario, 8 (18.6%) were from Saskatchewan, 5 (11.6%) were from Manitoba, 3 (6.98%)

were from Newfoundland and Labrador, 2 (4.65%) were from Alberta, and 1 (2.33%) paramedic service was from a blinded territory. The number of staff, a proxy for the size of the service, varied widely, between 17 and 960, with a sample wide average of 195 and standard deviation of 217.8. The staffing hours, another proxy for the size of the service, ranged from 13,000 to 2,080,000, with an average of 221,798 and 393,780. The average response rate per service was 9%, and ranged between 1.2% and 40.6%.

Table 5.1: Description of sample. ACP: Advanced Care Paramedic. PCP: Primary Care Paramedic. ICP: Intermediate Care Paramedic. CCP: Critical Care Paramedic. CP: Community Paramedic. RN: Registered Nurse. AB: Alberta. MB: Manitoba. NL: Newfoundland and Labrador. ON: Ontario. SK: Saskatchewan. T: Blinded Territory.

Individual Level (Paramedics) (n=502)	
Province	AB (43; 8.57%) MB (58; 11.55%) NL (14; 2.79%) ON (333; 66.33%) SK (44; 8.76%) T (10; 1.99%)
Gender	Male (335; 66.73%) Female (156; 31.08%) na (11; 2.19%)
Experience	Mean: 11.8 years. Standard Deviation: 8.9. Min: 0. Max: 37.
Rank	PCP (287; 57.17%) PCP+ (19; 3.78%) ICP (16; 3.19%) ACP (170; 33.86%) CCP (7; 1.39%) CP (1; 0.20%) RN (1; 0.20%) na (1; 0.20%)
Group Level (Paramedic Leaders) (n=43)	
Province	AB (2; 4.65%) MB (5; 11.63%) NL (3; 6.98%) ON (24; 55.81%) SK (8; 18.60%) T (1; 2.33%)
Number of Staff	Mean: 195. Standard Deviation: 217.8. Min: 17. Max: 960
Staffing Hours	Mean: 221,798. Standard Deviation: 393,780. Min: 13,000. Max: 2,080,000.
Response Rate	Mean: 9%. Standard Deviation: 7.1%. Min: 1.2%. Max: 40.6%

For the paramedics, 333 (66.33%) participants were from Ontario-based services, 58 (11.55%) were from Manitoba-based services, 44 (8.76%) and 43 (8.57%) were from Saskatchewan- and Alberta-based services respectfully, 14 (2.79%) were from Newfoundland and Labrador-based services, and 10 (1.99%) were from the service in the blinded territory. 335 (66.73%) of the paramedics were male, 156 (31.08%) were female,

and 11 (2.19%) provided no answer. The experience of paramedics ranged from 0 to 37 years, with a mean of 11.8 years and a standard deviation of 8.9. Regarding the ranks of the participating paramedics, 287 (57.17%) were Primary Care Paramedics (PCPs), 19 (3.78%) were PCPs with some additional training (PCP+), 16 (3.19%) were Intermediate Care Paramedics (ICPS), 170 (33.86%) were Advanced Care Paramedics (ACPs), and 7 (1.39%) were Critical Care Paramedics (CCPs). There was 1 (0.2%) participant each that indicated that they were a Community Paramedic, Registered Nurse, or did not indicate a rank.

5.2 Data Analysis

5.2.1 Measurement Model

WarpPLS 5.0 was used to estimate the measurement model, as it has the ability to assess non-linear relationships (Kock, 2015). It was further verified that the relationships among the variables were non-linear by examining the AARS of a model which uses the Linear Inner Model Analysis algorithm. This was substantially lower than the model that uses the Warp3 algorithm.

5.2.1.1 Convergent Validity

Several indicators were dropped from analysis as their cross-loadings were higher than their component loadings, including: *learn2*, *learn3*, *integrate2*, *integrate3*, *coordinate4* and *coordinate5*. Two items with loadings less than 0.708 were removed after it was found that their deletion improved the AVE and Composite Reliability of their respective variables: *relinf4* and *relinf5*. Table 5.2 (below) presents the item loadings after

these indicators were removed (See Appendix J – Paramedic Leader Item Loadings and Cross Loadings for all items).

Table 5.2: Loadings for retained items.

Variable	Item	Loading
Sense	sense1	0.826
	sense2	0.875
	sense3	0.84
	sense4	0.814
Learn	learn5	0.871
	learn1	0.666
	learn4	0.675
Integrate	integrate5	0.792
	integrate4	0.847
	integrate1	0.759
Coordinate	coordinate3	0.76
	coordinate1	0.712
	coordinate2	0.757
Dynamic Capabilities (formative)	DC_sense	0.885
	DC_learn	0.897
	DC_integrate	0.9
	DC_coordinate	0.751
Service Innovation Performance	sip1	0.892
	sip2	0.886
	sip3	0.885
	sip4	0.872
Reconfiguration Capability	reconfigure1	0.842
	reconfigure2	0.876
Integration	integration2	0.835
	integration1	0.657
	integration3	0.866
	integration4	0.729
	integration5	0.733
Relationship Infrastructure	relinf1	0.767
	relinf2	0.802
	relinf3	0.813
IT Business Expertise	itbusexp1	0.763
	itbusexp2	0.939
	itbusexp3	0.859
	itbusexp4	0.858
Technology Application Competencies	TAC	1
Information Processing Capability	IPC	1
Understanding of the Workings of Technology	UWT	1

As shown in Table 5.3 (below), the AVEs for each construct are all greater than 0.5. which also suggests a sufficient level of convergent validity (Hair et al., 2013).

5.2.1.2 Discriminant Validity

Three criteria were used to assess discriminant validity, referring to Table 5.3 (below). First, all indicator loadings were inspected and confirmed to be greater than any of their cross-loadings. Second, the Fornell-Larcker (1981) criterion requires the square root of the AVE of a latent variable to be greater than the correlation with any other variable. This is satisfied for most of the reflective variables. One exception (bolded) is the correlation between SIP and Learning Capability, a dimension of DC. Third, most of the correlations among the variables are all lower than 0.71 (Andreev et al., 2009). Exceptions to this rule exist between two variable pairs: SIP and Integrating Capabilities; and SIP and DCs. These exceptions are acknowledged as limitations of this research. In Table 5.3 (below), these are depicted as underlined numbers. The numbers within the shaded area of Table 5.3 (below) denote the constructs within the hierarchical components model, and as a high correlation is expected among these constructs, they can be excepted from this rule.

5.2.1.3 Internal Consistency Reliability

Internal consistency reliability was assessed using Cronbach's (1951) alpha and Composite Reliability (Hair et al., 2011; Bagozzi & Yi, 1991). All Composite Reliabilities were greater than the 0.6 threshold, as recommended by (Hair et al., 2011;

Bagozzi & Yi, 1991). Some Cronbach's alphas do not meet the guideline of 0.7 proposed by (Nunnally, 1978), specifically *Learning Capability* and *Coordinating Capability*, as well as the items for *Reconfigure*, which is included to ensure identification of the model. However, these figures comply with a more liberal guideline to detect internal consistency reliability, where all constructs have at least one of the Composite Reliability (CR) or Cronbach's alpha that is greater than 0.7 (Kock, 2015).

Table 5.3: Average Variance Extracted (AVE), Cronbach's Alpha (α), Composite Reliabilities (CR), Latent Variable correlations, and Square Root of AVE (italicized on the intersections). The shaded section includes the four lower order constructs and their parent higher order constructs. Italicized numbers indicate the AVE. The bolded number is the one violation of the discriminant validity criterion between Service Innovation Performance and Learning Capabilities.

Variable	AVE	α	CR	1	2	3	4	5	6	7	8	9	10	11	12	13
1 Sense	.704	.859	.905	*.839*												
2 Learn	.554	.589	.786	.73	*.744*											
3 Integrate	.64	.718	.842	.676	.809	*.8*										
4 Coord	.555	.597	.789	.611	.489	.588	*.745*									
5 DC	.74	.882	.919	.88	.89	.9	.766	*.86*								
6 SIP	.782	.907	.935	.688	**.784**	.718	.345	.747	*.884*							
7 Reconf	.739	.647	.85	.669	.551	.48	.52	.644	.451	*.86*						
8 Iation	.589	.822	.877	.674	.615	.564	.585	.707	.61	.449	*.768*					
9 RelInf	.632	.709	.838	.238	.279	.308	.369	.343	.246	.184	.361	*.795*				
10 ITBX	.745	.885	.921	.229	.207	.231	.449	.316	.151	.155	.333	.739	*.863*			
11 TAC	1.00	1.00	1.00	.002	.065	.088	.054	.06	-.08	-.08	-.08	-.01	.186	*1*		
12 IPC	1.00	1.00	1.00	.296	.096	.221	.27	.254	-.087	.103	.123	.146	.202	-.027	*1*	
13 UWT	1.00	1.00	1.00	.104	.178	-.043	.154	.004	-.218	.207	-.022	-.013	.119	.099	.168	*1*

5.2.2 Structural Model

The final model using PLS Regression with the Warp3 algorithm satisfies the overall model fit criteria (APC=0.298, p=0.009; ARS=0.415, p < 0.001; AARS=0.379, p < 0.001; ABVIF=1.965 < 3.3) (Kock, 2015). The AFCVIF of this alternative model with all constructs modelled as non-hierarchical components is 2.947, which is acceptable for analysis to continue. Figure 5.2 (below) summarizes the structural model, and full results of the significant relationships in the structural model are contained in Tables 5.4 and 5.5 (both below). As all block VIFs are below the 5.0 threshold, it is assumed that collinearity is not an issue (Hair et al., 2013). Given this, we can use the path coefficients, effect sizes (f^2), predictive relevance (Q^2) and coefficient of determination (R^2) to interpret the results (Hair et al., 2013).

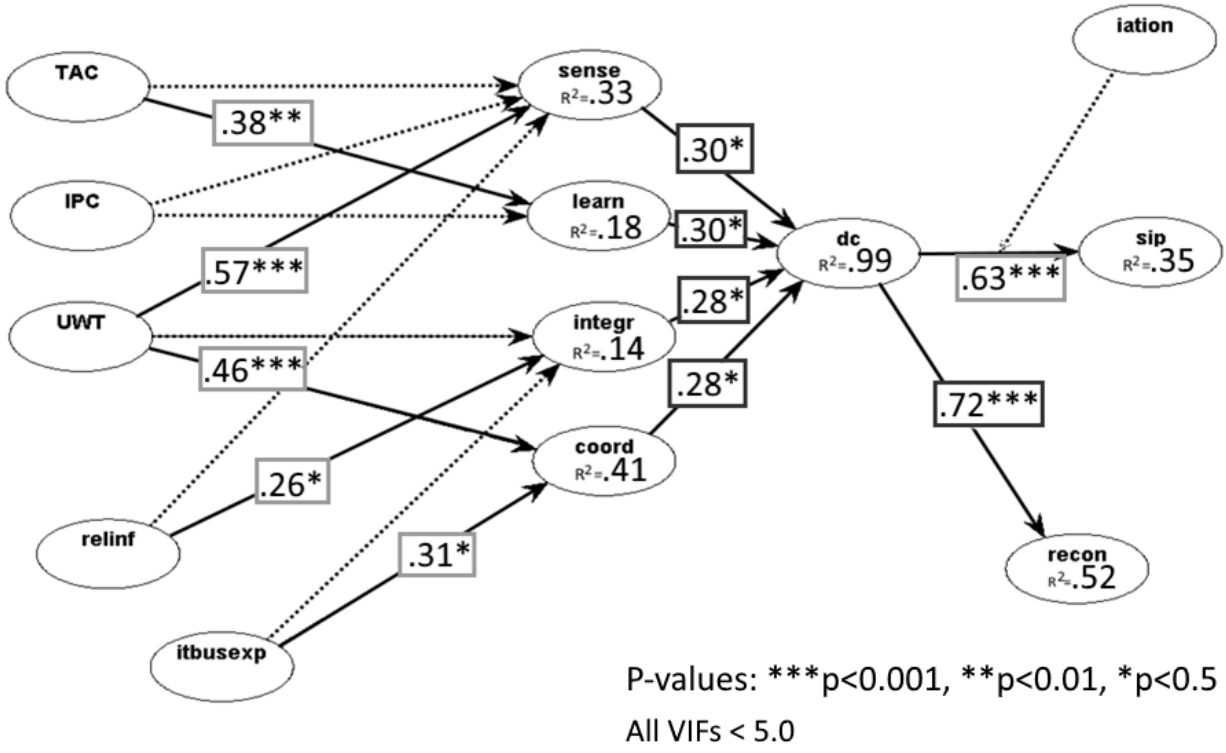

Figure 5.2: Structural Model Test Results. Significant relationships are denoted by bold lines, and non-significant relationships are denoted with dashed lines.

Table 5.4: Summary for support for structural model relationships. DC: Dynamic Capabilities. Iation: Integration. Relinf: Relationship Infrastructure. Itbusexp: IT Business Expertise. TAC: Technology Application Competencies. IPC: Information Processing Competencies. UWT: Understanding of the Workings of Technology. Sense: Sensing Capabilities. Learn: Learning Capabilities. Integr: Integrating Capabilities. Coord: Coordinating Capabilities. SIP: Service Innovation Performance. H: Hypothesis. IV: Independent Variable. DV: Dependent Variable. SE: Standard Error. VIF: Variance Inflation Factor. CI: Confidence Interval

H	IV	DV	Path coeff.	P	sig	SE	f2	VIF	T Ratio	95% CI	
										Lower	Upper
H1	DC	SIP	.627	<.001	***	.118	.480	1.717	5.314	.406	.848
H1a	Iation*DC	SIP	.213	.067		.140	.132	1.717	1.521	-.050	.476
H2a	Relinf	Sense	.176	.110		.142	.057	1.088	1.239	-.090	.442
H2b	Relinf	Integr	.263	.030	*	.137	.085	1.903	1.920	.006	.520
H3a	ITbusexp	Integr	.031	.419		.151	.008	1.949	.205	-.252	.314
H3b	ITbusexp	Coord	.305	.014	*	.134	.142	1.138	2.276	.054	.556
H4a	TAC	Sense	.143	.163		.144	.035	1.032	.993	-.127	.413
H4b	TAC	Learn	.379	.003	**	.130	.156	1.103	2.915	.135	.623
H5a	IPC	Sense	-.061	.342		.149	.026	2.660	-.409	-.340	.218
H5b	IPC	Learn	.104	.241		.146	.023	1.103	.712	-.170	.378
H6a	UWT	Sense	.565	<.001	***	.121	.332	2.813	4.669	.338	.792
H6b	UWT	Integr	-.171	.117		.142	.040	1.074	-1.204	-.437	.095
H6c	UWT	Coord	.462	<.001	***	.126	.263	1.138	3.667	.226	.698
	Sense	DC	.296	.017	*	.135	.262	2.716	2.193	.043	.549
	Learn	DC	.3	.016	*	.135	.269	4.209	2.222	.047	.553
	Integr	DC	.278	.023	*	.136	.254	4.223	2.044	.023	.533
	Coord	DC	.272	.026	*	.136	.21	1.822	2.000	.017	.527

Table 5.5: R^2, Adjusted R^2 and Q^2 statistics for this model.

Variable	R^2	Adjusted R^2	Q^2
Sense	.328	.257	.409
Learn	.179	.137	.193
Integrate	.133	.066	.164
Coordinate	.405	.376	.398
DC	.995	.994	.994
SIP	.348	.315	.626

R^2 values for all four first order constructs for DC (*sensing*, *learning*, *integrating*, *coordinating*) range between 0.133 and 0.405, which can be interpreted as weak, according to (Hair et al., 2011) The 0.995 R^2 for DC can be classified as substantial (Hair et al., 2011), and is a typical result of a higher order construct estimated with the two-stage model, as it should be

close to or equal to 1 (Becker et al., 2012). R^2 for SIP is 0.348, which Hair et al (2011) categorize as weak. All Q^2 values are greater than 0, indicating that the path models have a predictive relevance for their respective constructs (Stone, 1974; Geisser, 1974).

5.2.3 Precision

Confidence intervals were calculated for each hypothesis to describe the precision of the effect. These intervals were reported in Table 5.4 (above). The confidence intervals were constructed using the method as described in Kock (2016). The finite population correction factor was applied to the confidence intervals, and for this purpose, the population is estimated at 500 to result in a conservative confidence interval. The confidence interval of all significant paths are between zero and one, and the confidence interval of all non-significant paths span zero. For the significant paths, the confidence intervals span 40% or more, which can be interpreted as wide, and suggests that a larger sample is needed if more accurate estimations are desired.

5.2.4 Collinearity

As this model employs a formative variable that is constructed using the two-stage method, the full collinearity VIF will be artificially high, and therefore not valuable to use when diagnosing collinearity. An alternate method to assess the level of collinearity demonstrated by (van Reijsen et al., 2015) involves assessing the level of collinearity in an alternate model identical to the first, except with no hierarchical components. The alternate model, which has the four components of DC (Sensing, Learning, Integrating, Co-ordinating Capabilities) modelled directly antecedent to the SIP variable. The model in this configuration yielded Average Full Collinearity VIF (AFCVIF)=2.994, acceptable if equal to or less than 5, ideally if equal to or less

than 3.3 and an Average block VIF (ABVIF)=1.906, acceptable if equal to or less than 5, ideally if equal to or less than 3.3. All but two Block VIF measures (summarized in Table 5.4 (above)) exceed the recommended 3.3 threshold, and all do not exceed the more liberal threshold of 5.0. Given these results, it can be assumed that multicollinearity is not present. Table 5.6 (below) summarizes these results.

Table 5.6: Variance Inflation Factors for the assessment of Multicollinearity. AFCVIF: Average full collinearity VIF. ABVIF: Average block VIF.

Statistic	Result	Acceptability Criteria
AFCVIF	2.994	5 or 3.3
ABVIF	1.906	5 or 3.3

5.2.5 Summary of Hypotheses Supported

Table 5.7 (below) summarizes the hypotheses support. Out of the 13 hypotheses proposed, 6 are supported at the .05 level. Regarding the composition of DC as a higher order construct, all four lower order constructs significantly relate to the higher order construct of DC.

Table 5.7:Summary of the hypotheses in this research, as well as their support.

Hypothesis	**IV**	**DV**	**P**	**Significance**	**Support**
H1	DC	SIP	<.001	***	Yes
H1a	Iation*DC	SIP	.067		No
H2a	Relinf	Sense	.110		No
H2b	Relinf	Integrate	.030	*	Yes
H3a	ITbusexp	Integrate	.419		No
H3b	ITbusexp	Coordinate	.014	*	Yes
H4a	TAC	Sense	.163		No
H4b	TAC	Learn	.003	**	Yes
H5a	IPC	Sense	.342		No
H5b	IPC	Learn	.241		No
H6a	UWT	Sense	<.001	***	Yes
H6b	UWT	Integrate	.117		No
H6c	UWT	Coordinate	<.001	***	Yes

5.3 Conclusion

The purpose of this chapter is to test the theoretical model, as presented in Chapter 3. In doing so, the results support the first three research questions of this dissertation: (RQ1) *Do the organizational abilities to reconfigure and integrate with other community partners influence the ability of the paramedic service to innovate?* (RQ2) *Do IT Service Provider related capabilities influence a paramedic service's ability to innovate?* and (RQ3) *Do the technology-related knowledge and skills possessed by paramedics influence the ability of their respective services to innovate?* The analysis in this chapter reveals support for the 6 out of the 11 hypotheses proposed in this research. Generally, results show that IT Capabilities and Group-level Competencies each affect different dimensions of DCs, and there is strong support for DCs as an antecedent to SIP.

Chapter 6: Results - Qualitative Phase

The purpose of this chapter is to elaborate on the findings from the qualitative phase of the study. In doing so, this chapter seeks to answer the fourth research question proposed in this dissertation: (RQ4) *What factors are associated with paramedic services' ability to innovate?* In order to accomplish this, using a sequential explanatory approach from mixed methods research (Creswell & Plano Clark, 2011), participants from the first phase were purposefully selected for participation in the second phase, based on their SIP scores from the first quantitative phase. Participants that have agreed to this phase of the study were classified as either Higher than Average Innovators, or Low to Average Innovators, based on an average score that they entered for the Service Innovation Performance items in the previous phase.

Between January and April 2016, the researcher conducted in-depth telephone interviews with Low to Average Innovators (5 sites) and Higher than Average Innovators (6 sites). All calls were recorded, transcribed, reconciled with the researcher's notes, and subjected to thematic analysis for similarities and differences between the two groups. 19 themes (3 of which are broken down into subthemes) were extracted. Inter-rater reliability, measured by percentage agreement and Kappa scores, were generally sufficient. The themes were validated by a senior Paramedic Leader from Ontario, who was a past president of a provincial association of paramedic chiefs.

6.1 Intermediate Phase - Identifying Potential Participants

When using the sequential explanatory approach to mixed methods research, there is typically some data analysis that occurs between the two phases, for the purpose of selecting participants for the second phase, based on some of the findings of the first phase (Creswell &

Plano Clark, 2011). Commonly referred to as an "intermediate" phase, this may involve a variety of techniques to select participants who will provide insights that support the research question and result in stronger findings. These techniques, where participants from the first quantitative phase are purposely selected for the second qualitative phase based on their performance, is referred to as "connecting" (Creswell & Plano Clark, 2011). It is important to select appropriate participants in a systematic manner (Ivankova, 2014) to ensure the validity of the results (Creswell & Plano Clark, 2011). Several techniques can be used at this point, including purposively selecting participants based on a criterion of some sort or performance on a certain score (Patton, 1990). Alternatively, the selection process may require that the diversity of the second phase participants is ensured by purposely selecting several participants from a variety of subgroups or a wide span of scores (Patton, 1990).

The sampling method used for this phase was purposive, meaning that the participants were not selected at random, but were selected based on their performance on a score to ensure a representativeness of the sample (Patton, 1990). As the research question seeks to identify facilitating or inhibiting factors with respect to a service's ability to innovate, this phase will make use of purposely and systematically selected participants who exhibit either high or low innovation performance. This is referred to as "intensity" sampling, where the intensity of a measure will qualify sites for participation in this phase, in order to enable the discovery of the reality of innovation at a diverse variety of sites (Patton, 1990). As the research question for this phase indicates a broad interest in the ability to innovate, sites were selected based on either a high or low performance on their SIP score.

To accomplish intensity sampling, an approach for this research was developed for categorizing cases into two categories: Higher than Average Innovators, and Low to Average Innovators. Higher than Average Innovators will have had to indicate that they perform higher than their peers on at least one of the SIP items. This translates to indicating that they scored 4 or higher on most of the SIP items. Low to Average Innovators will have indicated that they were "average" or below on all four SIP Items. Table 6.1 (below) contains the SIP items and scale for reference, and Table 6.2 (below) contains the scores on these items for the individual paramedic services that participated in this phase of the study. Due to the limitations in available participants for this phase, the small difference between the "highest" site in the Low to Average Innovators group and the "lowest" site in the Higher than Average Innovators group should be noted as a limitation (See the Limitations section in Chapter 7). However, as previously stated, there is a perceptual difference between "Average" and "Higher than Average", and these groups are constructed with this perceptual difference in mind.

Table 6.1: Service Innovation Performance (SIP) Items from the Paramedic Leader Questionnaire, as well as their scale.

SIP1	As compared to other paramedic services, what is the level of your services' innovation efforts in meeting citizens' needs?
SIP2	As compared to other paramedic services, what is the level of your service's success rate in implementing innovations in the past 3 years?
SIP3	As compared to other paramedic services, what is the level of your services' overall service innovation performance in the past 3 years?
SIP4	As compared to other paramedic services, what is the percentage of performance improvement attributable to service innovation in the past 3 years?
Scale	Very High (5), High (4), Medium (3), Low (2), Very Low (1), NA/No Answer

Table 6.2: Scores for sites that participated in this phase of the study. Sites have been categorized as "Low to Average Innovators" or "Higher than Average Innovators", based on their average performance across the four SIP items.

Site	**Sip1**	**Sip2**	**Sip3**	**Sip4**	**Sipavg**	**z-score**
Low to Average Innovators						
L1	1	1	1	1	1	-2.71
L2	1	1	1	1	1	-2.71
L3	3	3	2	2	2.5	-0.99
L4	3	3	2	2	2.5	-0.99
L5	3	3	3	3	3	-0.41
Higher than Average Innovators						
H1	4	4	4	3	3.75	0.45
H2	4	5	4	3	4	0.74
H3	5	4	5	3	4.25	1.03
H4	5	4	5	4	4.5	1.31
H5	4	5	5	4	4.5	1.31
H6	4	5	4	5	4.5	1.31

6.2 Results

Data collection took place between January and April of 2016. Interviews took place over the telephone, and lasted between 32 and 62 minutes. The researcher found that 11 interviews were sufficiently validated, which is when saturation was reached (newer participants were not adding further knowledge to the results) (Lee, 1999). Participants were asked explicitly if they consented to having the interviews audio recorded, and all participants agreed to this. After the interviews, all audio files were transcribed by the researcher, and input to nVivo 11 for thematic analysis. Table 6.3 (below) contains some extended descriptive statistics for the participants in this phase.

Table 6.3: Second Phase Participant Descriptions

Site	**Respondent Rank**	**Province**	**# Paramedics**
L1	(blinded)	NL	< 100
L2	(blinded)	ON	< 100
L3	Manager	MB	> 300
L4	Director	MB	> 100
L5	Director	SK	> 100
H1	Deputy Chief	ON	> 200
H2	Superintendent	ON	> 200
H3	(blinded)	SK	> 100
H4	Deputy Chief	ON	> 100
H5	Superintendent (delegated)	ON	> 200
H6	Deputy Chief	ON	> 500

Analysis yielded 19 distinct themes from the interviews, 3 of which contained subthemes. One other rater (a doctoral candidate in Business Administration) was used to ensure a sufficient level of interrater reliability. The other rater was provided access to the code book and corpus, and instructed to code the transcripts using the existing code book. Conflicts between the interpretation of the researcher and other rater were resolved through discussion. Percentage agreement for all themes was between 98.87% and 99.82%, and the Kappa was between 0.70and 0.94. See Table 6.4 (below) for a summary.

*Table 6.4: Summary of the 19 emergent themes. * This theme contains subthemes, which are detailed in their appropriate sections. † As this theme contains subthemes, the agreement statistics are presented where the subthemes are articulated. %agg: Percent Agreement.*

	Kappa	%agg	L1	L2	L3	L4	L5	H1	H2	H3	H4	H5	H6	Tot
Organizational Facilitator														
- Uses an ePCR*	†	†		X				X	X	X	X	X	X	7
- Employee Empowerment and Engagement	0.7720	98.99		X	X	X	X	X		X	X		X	8
- Seeking Knowledge from Outside the Organization	0.7747	99.21		X		X				X	X	X	X	6
- Collaboration and Integration with Partner Organizations	0.8024	99.55		X		X	X	X					X	5
Organizational Inhibitor														
- Governance *	†	†	X	X	X	X	X	X	X	X	X	X	X	11
- Change Management	0.7022	99.60	X	X		X	X	X					X	6
- Data Communication Infrastructure	0.8019	99.61		X		X	X			X	X			5
- Lack of ePCR*	†	†	X		X	X	X		X					5
Paramedic Facilitator														
- Help Others with Lower Technology Skills	0.7251	99.38	X	X				X	X	X	X			6
- Bring External Ideas into the Organization	0.7056	99.46	X	X				X			X		X	5
- Change Culture and Encourage More Innovative Thinking	0.7788	99.82	X				X	X		X			X	5
- Adapt to Changes in the Field	0.8169	99.46		X	X						X			3
- Identify Areas for Change	0.7180	99.71	X				X		X					3
Paramedic Inhibitor														
- Age Effect	0.7096	99.71	X	X			X	X	X	X	X			7
- Slow Down Efficiency	0.7638	99.74	X	X			X		X	X		X	X	7
- Lack of Vision	0.7175	99.48	X				X	X					X	4
- Low-Impact Problem	0.7976	99.69		X						X		X	X	4
- Overreliance is Dangerous	0.8092	99.72							X	X				2
- Sabotage, Misuse, Abandonment etc	0.7267	99.54		X			X							2

6.3 Organizational Level Facilitators

6.3.1 Use of an ePCR

Upgrading from a paper-based patient care record to an ePCR affords many benefits to the organization. As several relevant factors seemed to be related to the use of ePCRs by the service, this topic was explored at a slightly more focused level. Table 6.5 (below) shows a

matrix that compares the performance group that the site belongs to versus their use of a paper or electronic PCR. It seems that the low to average performing group largely still uses paper-based PCRs, and the higher than average group have all adopted ePCRs. There is one exception (L2), and this low-performing exception had just recently adopted an ePCR at the time of the study.

Table 6.5: Comparing Low and High Groups to the Types of PCR Used by Each (Paper vs Electronic).

Group/PCR Type	Paper	Electronic
High	0	6
Low	4	1

Table 6.6 (below) shows the subthemes that are related to the use of ePCRs. These subthemes are restricted to the services that have adopted the ePCR, although there are parallels with services who still use paper-based PCRs (See Section 6.4.4 Lack of ePCR, below). The subthemes to ePCR use are as follows: Ease of Documentation and Reporting, Clinical Quality Assurance and Improvement, Seeking and Justifying Operational Improvements, Integration with Other Devices and Datasets, and ePCR was a Revolutionary Change. These themes will be explained below.

Table 6.6: Subthemes related to the use of an ePCR. %agg: Percent Agreement.

	Kappa	%agg	L2	H1	H2	H3	H4	H5	H6	Total
Ease of Documentation and Reporting	0.80	99.3	X	X	X	X		X	X	6
Clinical Quality Assurance and Improvement	0.78	98.9	X	X		X	X			4
Seeking and Justifying Operational Improvements	0.94	99.4			X	X	X			3
Integration with Other Devices and Datasets	0.83	99.5		X	X		X	X	X	5
EPCR was a Revolutionary Change	0.73	99.7		X	X		X	X	X	5

6.3.1.1 Ease of Documentation and Reporting

The most prevalent benefit related to the use of an ePCR seems to be the ease in both the ways that documentation is entered into the system, and the ease in constructing *ad hoc* reports

from the ePCR data ("data pulls", to use an *in vivo* term). After every call, paramedics must record details about the call, containing clinical and operational information such as the primary problem on arrival, the acuity of the patient on the Canadian Triage and Acuity Scale (CTAS), whether lights and sirens were used, and so on. The paramedics are often supplied a heavy-duty laptop or other technology in the ambulance so that these reports can be filled out remotely, as well as desktops as their stations. All paramedic services are required to keep these records. The participant from H5 states:

> *"I think it would if anything streamline [the paramedic's] job or make it a little quicker. Majority point of view, instead of sitting down charting for a long time they might make them a little quicker."*

There is also a sentiment that the ePCR helps increase data quality. They have common features that ensure data quality, such as ensuring that the forms are submitted correctly. If the forms are not complete the system won't accept them. The participant from H2 states:

> *"You can't submit a form if you haven't filled out certain areas. So the close call rules identify okay well you're missing required information. Unless you know how to back and get that information or know where to put it in you can't submit that form"*

It seems that the ePCR data is highly trusted by paramedic leaders. Having a high quality and trusted data source allows for ease in generating reports that serve a variety of purposes. The participant from H3 explains how the ePCR allows their service to easily participate in a national research program, where ePCR data from many services are aggregated and analyzed.

> *"We would use [the data for] … participating in the ROSC study. So having that data that you can pull in a matter of minutes, compared to a stick tally by reviewing paper. There is no comparison."*

This ease of access to this data has translated into administrative cost savings. The participant from H6 explains:

> *"It has cut down the amount of administrative time and work that's required to get the clinical information back and forth so that we can get it more quickly if there is a critical trending issue"*

6.3.1.2 Clinical Quality Assurance and Improvement

Use of the ePCR has enabled many important endeavours at the paramedic services that have adopted it. It seems that many of these services utilize the data for various clinical quality assurance and improvement endeavours. Services access this data periodically by creating ad hoc reports, determine ways in which the service as a whole can improve, and organize a service-wide training program to increase skills. This technique also can be used to determine if the service is compliant with various service standards, or can drive improvement in certain high priority areas, such as stroke, cardiac or HALO (High-Acuity, Low Opportunity) events. Alternatively, it can be directed at improving skills using certain techniques, such as intubation, IV starts or chest compressions. The participant from L2 (a recent adaptor of ePCRs) explains:

> *"So we can actually track down … how many [paramedics] did intubation, how many started IVs,… how many did cardio … And then based on that information, we'll provide some opportunities for training"*

The participant from H1 explains how they may target specific paramedics for skills improvement, in a non-punitive way:

> *"And we are randomly auditing our ambulance call reports…. if they see things that are contrary to standards or legislation…. we don't really go punitive on that. We bring it to their attention and make sure they correct their form"*

6.3.1.3 Seeking and Justifying Operational Improvements

Aside from clinical improvements, the ePCR data has been used to improve the service operationally. This entails the investigation of a variety of issues, including shoot times (time from receiving the call to the crew leaving the station), non-consents (a situation where a patient

does not consent to being transported to the hospital), or seeking opportunities for bypassing (sending certain high-acuity patients such as trauma or Segment Elevation Myocardial Infarction (STEMI) patients to specialized hospitals or departments). Regarding the latter issue, the participant from H4 responds:

> *"There are a number of bypasses that already exist… [such as the] STEMI bypass, there's a trauma bypass… there are other opportunities for us to look at efficiencies and getting our patients to the correct location in a timely fashion. … and that can be done by looking at the data that we have"*

As well as seeking opportunities for improvement with these reports, the data are also used to justify these system changes to various stakeholders. These reports will largely be used to demonstrate that an opportunity for improvement does indeed exist, and that an impact can likely be made with a proposed improvement. The participant from H3 explains how data are used to gain approval for an innovation:

> *"If every discussion that happens in the hallway has merit, then we'll take it to the next level and do some data searching and really see the volumes there … then we'll go to our region and say here's an idea, are you willing to entertain it, because funding has to come from somewhere"*

6.3.1.4 Integration with other devices and datasets

Another way in which the data from the ePCR is used involves integrating it with other datasets. These datasets can be from devices such as public defibrillators, which can be used to drive clinical quality improvement. As well, these datasets can be from other organizations, such as dispatch centres, hospitals, as well as publicly available datasets. Reports derived from the data can be used to drive both operational and clinical quality. The participant from H5 explains:

> *"Every single cardiac arrest case has data entered into [the ePCR] and so what I do is review all the 12-lead information and technology allows us to give the paramedics feedback on their CPR performance."*

As well, integrated ePCRs often are used to notify other agencies of certain details of a call in real-time, for shorter off-load times or other benefits. The participant from H6 explains:

> *"Giving the hospital better awareness of patients that are incoming, so they can start to think about where they're going to put these people when they get there, which is helping to decrease offload time."*

6.3.1.5 ePCR was a Revolutionary Change

There seems to be an effect that the implementation of an ePCR has brought about regarding a change in technology-related abilities and attitudes among the paramedics. After implementation, it seems that Paramedic Leaders have noticed that their paramedics are less resistant to technological innovation, and adopt technology with more ease than before the implementation of ePCRs. The respondent from H5 explains:

> *"When we made the change from paper charts to electronic charts, that was obviously quite the big hurdle but I don't think anybody now would go back to a paper form. So a big hurdle at the start but I think it's just accepted now that this is the world we live in."*

6.3.2 Employee Empowerment and Engagement

This theme pertains to the use of many strategies to engage paramedics in change, empower them to act independently, or to drive their own innovative change within the organization. A fair amount of ideas emerge from the front line paramedics, as they are the most knowledgeable about their needs. Although some sites experience a small number of paramedics coming forward with ideas, a difference is when paramedics "champion" an idea, for the benefit of the entire service. In this case, the service may provide support to this paramedic, from small scale pilot studies all the way through implementation. Participation on various internal and external committees is also seen as a way that paramedics can develop a specialized expertise, and enhance their career prospects and contributions. As well, recognition for paramedics who

contribute in this manner will also help to communicate to all staff the behaviour that the service values. A Paramedic Leader explains how Paramedics can be engaged to drive their own agenda within the service under the CP umbrella:

> *"not only does it benefit the service, and patients, but I look at it as career pathing. a medic comes into this field in high hopes of making change and a lot of them do, however reality says that an ACP does not want to be humping stretchers for 20 years and working shift work. so if we can do innovative things and CP is the biggest innovative thing that we have done here and probably 4 or 5 different programs where right from our PCPs to our ACPs are involved with and it gives people something different to do and gives them different education."*

6.3.3 Seeking Knowledge from Outside the Organization

At an organizational level, certain actions and policies exists where knowledge is sought from outside the institution. This could be by leader action, or organizational policy that encourages this activity among paramedics. If the service is operated by a private company, there are corporate level resources to draw on. In the case of Paramedic Leaders, they often attend conferences and seek ideas that are being applied elsewhere, and question how they would attempt to apply them in their own service. Many ideas are exchanged through national or regional Paramedic Leader working groups and committees. The participant from H3 tells about a system that exists in Australia that could have applications for a problem that their service is facing:

> *"I'm going to talk about the patient referral system that I saw in Australia. I saw this and I said man this would solve so many problems. because we were transporting so many inappropriate patients to the [ED]."*

6.3.4 Collaboration and Integration with Partner Institutions

This theme refers to the degree to which the EMS will collaborate, share data, plan, and perform other beneficial activities with other organizations, including base hospital, various

inter-organizational committees and organizations. Also, the benefits to future and increased integration can be identified and articulated. This theme goes beyond simple knowledge sharing in that inter-organizational collaboration takes place. In particular, the amount of collaboration with the base hospital of the service seems to be beneficial. This relationship has yielded several innovations, such as the use of a smart phone app that can help paramedics rate the acuity of patients on the CTAS, and the introduction of an innovative drug throughout many services in the surrounding region. It has also been used to seek advice on future equipment purchases for the service. A Paramedic Leader from a Higher than Average performing services explains how a paramedic has affected an innovation (a medication used for opiod overdoses) in collaboration with a base hospital:

> *"So our paramedic rep had that idea and then we talked about it with our base hospital and eventually that was brought forward to [the] medical oversight committee…. [the paramedics] have training and access to naloxone and last year we started carrying it on the trucks."*

6.4 Organizational Level Inhibitor

6.4.1 Governance

This theme pertains largely to issues surrounding the selection of projects, the release of funding by governing organizations and need for collaboration among partner organizations. Despite adequate demonstration that certain changes are needed, the lack of support from the governing body can prevent or delay implementation. This theme contains 4 subthemes: Budget Constraints, Overly Restrictive Governing Body, Other Departments and Partners Approval, and Lack of Project Management Resources.

Table 6.7 (below) summarizes these themes, and will be elaborated in detail below.

Table 6.7: Subthemes related to governance. %agg: Percent Agreement.

	Kappa	%agg	L1	L2	L3	L4	L5	H1	H2	H3	H4	H5	H6	Total
Budget Constraints	0.75	99.7		X		X	X			X		X	X	6
Overly Restrictive			X	X	X	X	X		X	X				7
Governing Body	0.90	99.5												
Other Departments and			X				X		X	X	X			5
Partners Approval	0.86	99.7												
Lack of Project				X			X	X	X					4
Management Resources	0.70	99.7												

6.4.1.1 Budget Constraints

This theme pertains to situations where funds are not available for information technology and other projects. This is largely a restriction that is internal or unspecified. The participant from L5 states:

> *"I think the biggest barrier to us is really just the access to the finances to make it happen."*

The participant from H6 agrees:

> *"Sometimes the money isn't there, right, to try new things."*

6.4.1.2 Overly Restrictive Governing Body

This theme pertains to situations where it is difficult for paramedic services to attain approval from governing bodies for certain projects. This restrictiveness goes beyond the normal requirements of applying for funding, such as medical oversight or availability of money, and although the benefits of this project can be demonstrated, no approval is obtained. Often the decision to proceed with an innovation relies on administrators, who are not necessarily healthcare professionals. The participant from L2 tells about the issues dealing with the overseeing municipality:

> *"The final say really goes to the district municipalities that you report to, because it doesn't really matter what is working great somewhere else, if the municipality doesn't want to adopt it, then they don't adopt it… the shoulders that it fall on are the municipality because they're still the ultimate driver."*

Some services that are governed by regional health authorities also feel the same effect, and are discouraged and disappointed, such as L1:

> *"We're EMS but we're part of the health region. So even though we from an EMS perspective see this as a priority, it may not be looked at as a priority from the health authority perspective … I'm not in control of my own world for the most part."*

This is a source of frustration for some paramedic leaders, including the one at L3:

> *"We do not have ePCRs linked to [the provincial system]. Only [neighbouring large city] does. We were promised this years ago. That has gone nowhere and we feel we are behind."*

6.4.1.3 Other Departments and Partners Approval

This theme pertains to situations where collaboration is needed among other organizations to introduce an innovation, and the other organizations are not cooperative, or somehow disagree with the innovation, resulting in nothing happening. These departments can be an IT department or hospital, or any other partner that may have a bearing on a decision. This underlines the interdependent nature that paramedic services have with other departments. The participant from H2 explains some of the details that are involved in setting up a link between the paramedic service and a hospital:

> *"To do a direct link to a hospital, there's a lot involved in it, not just from a technology point of view but from a policy point of view; data-sharing agreements, breach policies, all that kind of stuff."*

The participant from H3 explains the importance of buy-in from physicians:

> *"I think you need the medical practitioners on your side. We need the docs to say that we want to be involved in this"*

6.4.1.4 Lack of Project Management Resources.

This theme pertains to situations where innovation is stalled because of the labour involved with pushing it forward. These processes, which can involve the construction of

business cases, participation on committees, and other similar activities, are a lot of work, and people get discouraged when they see the amount of work it takes to get something implemented. The participant from L5 explains:

> *"[the staff] have all sorts of great ideas until they have to do the work."*

The participant from H2 explains the identified need to manage projects more efficiently:

> *"I think there's a business need to have those things in place, like project management, so … we're not doomed to repeat the same things over and over again, that we can learn from previous projects so that future projects can benefit from it."*

6.4.2 Change Management

This theme pertains to the need to roll out technologies and interventions in a deliberate way to ensure its successful use by paramedics, and avoid pitfalls of user resistance, overburden, and other unintended negative effects. Resistance by paramedics can have a negative impact on change, as explained by the participant from H1:

> *"Change tends to be a bit of a touchy subject at times. We see [resistance] but I have to say it's not as bad as I had seen in the past, but it is getting better, but there is always a group of people that will show you why it isn't going to work and it's a bad idea. and I say that's probably, depending on the idea, 15%-20% [of paramedics]"*

This is an issue that Paramedic Leaders seem to be aware of, and various strategies need to be considered before rolling out new technologies or other innovations. The participant from L1 explains that communication with the paramedics is important:

> *"It comes down to really communicating - communicating it to, you know, some of the, well I'll say the older guard, that, you know, here's what we're going to do and why. There's always uncertainty because it's something new."*

Timing of implementation is important, as explained by the participant from H6:

> *"We made the mistake of rolling out too much too quickly once and learned from that… we just overburdened and overwhelmed folks … we learned a lot on the change management piece for us. And that was our … mistake."*

The participant from L5 also warns of implementing too many changes at once:

> *"We try to minimize change as much as possible, even if we don't want to change for the sake of just changing."*

6.4.3 Data Communication Infrastructure

This theme pertains to the need for reliable wireless data communications infrastructure to facilitate the use of remote use of connected information technologies. This concern is especially important for services that cover a wide geography, or are located away from major centres, as explained by the participant at L5:

> *"The rural environment itself, we don't have high speed everywhere. Cell coverage is spotty in different locations, that hampers us."*

6.4.4 Lack of ePCR

As discussed above, there are many benefits to adopting an ePCR that can be realized by the paramedic service. Unfortunately, for those services who still use paper based PCRs, these benefits cannot realistically be attained. The subthemes here pertain to the negative impacts of paper based PCRs, and the awareness of the benefits of ePCRs despite not using them. Table 6.8 (below) summarizes these subthemes.

Table 6.8: Subthemes Related to the use of Paper Based PCRs. %agg: Percent Agreement.

	Kappa	%agg	L1	L3	L4	L5	Total
Negative Impacts	0.82	99.6	X		X		2
Aware of Benefits of an ePCR	0.89	98.9	X	X	X	X	4

6.4.4.1 Negative Impacts

This theme pertains to the various negative impacts that are experienced by the paramedic service that does not have an ePCR. The participant from L4 explains the security and privacy vulnerabilities with a paper-based PCR:

> *"Well, I'm struggling right now. Confidentiality, these papers are sitting there in the station, they need to be locked up, the station needs to be locked up but there's a lot of traffic in there … it'd be nice if things were completed once the data's collected and sent off and not accessible anymore. Then you don't have third parties picking it up, finding out who picked up who in the community yesterday."*

The participant from L4, a rural service, also explains that the lack of ePCR is discouraging for potential paramedic hires that wish to use innovative technology:

> *"It's a recruitment thing. You get to use the ePCR and you live within the urban site … and they get all the cool stuff. So if I bring it back, I'll be able to recruit and retent (sic) more, it'll be proactive."*

6.4.4.2 Aware of Benefits of an ePCR

Despite the lack of ePCRs, these participants demonstrate an awareness of the benefits of their use, and they are currently desired. These benefits can include the ability to audit for clinical improvement, better security and privacy protection, faster data input and retrieval, and a variety of others. The participant from L1 states:

> *"I can't drill down to see types of patients, ages of patients, types of interventions, all that kind of stuff, which we really see the need to move that paper-based system into an electronic format to better, you know, get a better handle on what we're actually doing clinically and operationally."*

The participant from L4 identifies that the ePCR could allow them to engage in clinical quality improvement, similar to other services, as described in detail above:

> *"Huge. It's the way of the future. It's to be able to share information, get your answers immediately. Diagnostics treatment, technology will help us innovative and lead … they get feedback quicker on their care delivery and their treatment skills and we can educate and train."*

6.5 Paramedic Level Facilitators

6.5.1 Help for Others with Lower Technology Skills

This theme is important when an innovation is introduced to the paramedics, some of whom are struggling to learn how to use it. The paramedics with higher skills often mentor or help paramedics with lower skills to use newly implemented technology. This seems to be a common practice that is encouraged by the services, regarded as effective, and is not a large draw on organizational resources. The participant from H1 describes how paramedics may be paired up on a shift for this reason:

> *"They may pull a shift with somebody who isn't up to speed and show them hey this is how that works better... or hey did you know this? I think you see that daily in the field, whether it comes to our technology and some gaps that the non-advanced paramedics don't know, they get filled in with that."*

The participant from L2 describes how this method is used to enhance formal training:

> *"One of the things that we did when we first implemented the electronic patient care records was identify what we would call power users, or people who were very friendly with technology, and yes we did a formal training day where we had everybody in a classroom, but people were not restricted from starting to use it prior to that day. So what they would do was, the keeners would go on and they would just use it, and they would say, wow this is much better or easier, and then demonstrate and help the other people. They become the mentors for us."*

6.5.2 Bring External Ideas to the Organization

This theme pertains to paramedics performing activities that bring external knowledge into the organization. The paramedic is largely self-motivated with these activities, and pursues them on their own time, or as part of a service-sanctioned activity (i.e. a "sandbox" for the paramedic interested in a certain area). The participant from H1 describes the extent that paramedics share information online:

> *"And these guys bring a lot forward. You got ems1.com [a paramedic themed website] that's pumping out online training and news articles all the time and I see the keen ones on it, posting it and sharing it… ems1.com is a great resource."*

The participant from H6 describes the knowledge sharing behaviour among their paramedics, as well as the notion of paramedics scanning the environment for new innovations:

> *"If there's an innovation that happens somewhere else in the world they'll probably know about it sooner than I will…the e-lists, and blogs and all of this… great stuff that you can get right to your smartphone following … what they're doing in the United States, or Europe or Australia."*

Services provide opportunities for paramedics to attend conferences for recognition and networking, as described by the participant from H4:

> *"It's allowing them the opportunity to follow through with the ideas that they have. So for example, at [a recent] conference that occurred … we sent three individuals to that conference as a way to recognize their contribution to our QA process."*

6.5.3 Change Culture and Encourage More Innovative Thinking

Paramedics that are innovative spread a positive attitude towards innovation in the service. This is largely done in a passive manner (i.e. because people get word about new and interesting things, or other paramedics positive accomplishments). The participant from L5 describes the impact that innovative paramedics have on the culture:

> *"It creates a sense of excitement and it gives people the idea that the [paramedics] can also create innovation to occur in the organization."*

6.5.4 Adapt to Conditions in the Field

During actual calls, paramedics may spontaneously access technology on the fly to assist them. This requires "thinking on their feet", but often is credited with changing the outcome of some calls for the better. The participant from L2 recalls situations where smart phone apps were used to assist paramedics while on a call:

> *"All of our base hospital standards I think are available now on smart phones. Lots of people use apps. They use different sites to look at medication. They can, you know, quickly figure out a patient - like, whatever medication a patient's on, they can access it quickly at their fingertips to know if they're having side effects from it."*

The participant from L3 refers to a similar context, where personally owned technology is used in the field:

> *"Anything the medics do is delegated from the medical director. All of those delegations are very strict protocols. They have them all on an app. All those protocols are downloaded onto a personal device, and that's what they all use in the field. About 90% of them do, others use the hard copy. 90% of them use their personal devices when and where they need them."*

The participant from H4 states that adaptability is in general an important quality for paramedics to have:

> *"By nature the business attracts individuals that are able to adapt because even in a one call, it's never ever the same as the previous call that you did, so you need to have that as a skill. You need to have that … ability to be able to adapt."*

6.5.5 Identify Areas for Change

Paramedics can be inspired to innovate with knowledge of a certain technology or a way of doing things, and know how it applies to their practice, and also how to apply it. This largely

is a result of the knowledge and experience that comes from knowing the job very well. Paramedics will eventually see the shortcomings related to certain tasks, giving way to ideas on how to improve it. The participant from L1 states how inspiration comes from knowledge of the job in tandem with technological knowledge:

> *"Some of these things come forward from the staff because they see a better way to do it because they're entrenched with the day-to-day … somebody embedded in the day-to-day operations that has comfort with knowledge, with the perspective of technology and can look and seek for those ideas."*

The respondent from H2 believes that paramedics will notice opportunities with knowledge of technology, and see where performance improvement can be made:

> *"So it may influence things like future purchases where you say 'The next defib that we want to get, I want it to have two settings for pulse oximetry. I want it to have an adult setting and a pediatric setting' because the pediatric sensing, because they're smaller, is going to have higher sensitivity, and it will allow us to provide better clinical care because the technology now has two sets of defaults … the people who can use it to the fullest understand where the potential is to gain the most."*

6.6 Paramedic Level Inhibitor

6.6.1 Slow Down Efficiency

Paramedics with lower technology-related skills are slower at normal tasks. These can include data entry, looking at maps, receiving organizational communication, and other various activities that are required as part of their job. The participant from H5 explains:

> *"The biggest hindrance I guess would be speed, so it might take you a half hour to do a form on your computer and then you back out to the streets and do another call whereas the slower medic might be like 45 minutes an hour doing a form and that slows down the system."*

6.6.2 Age Effect

This theme captures the tendency for older paramedics to resist change and the use of new technologies. The participant from H3 explains:

> *"It's not so much a struggle for the newer staff, it's more of a struggle for the seasoned veterans."*

The participant from L5 explains:

> *"I worry a little bit about the older paramedics as they start to get older, it gets a little harder to pick up on some of the stuff."*

6.6.3 Lack of Vision

Paramedics without an innovative vision do little to contribute to the improvement of performance. The participant from L5 explains:

> *"Well, they damage that culture because of course, they're ... complaining, 'This is stupid, I shouldn't have this'"*

The participant from H6 explains how some paramedics don't see the need to contribute to change:

> *"Most of [the paramedics] are very contentious to come in, and do their piece of the work and let other folks that are curious, and naturally creative and innovative to do that heavy lifting for them."*

The participant from H1 explains how some paramedics don't see their part in a larger system of quality improvement:

> *"They don't see a bigger picture of data collection and process improvement."*

The participant from L1 explains that the training that paramedics receive does not include this as a focus:

> *"There's nothing there really that addresses technology and being able to use technology, and I think there's an area there that needs to be probably further developed within the programs and in the national [competency] profiles."*

6.6.4 Small Problem

Paramedics with insufficient tech related skills and knowledge pose a problem with very little impact on the service. In other words, this is not something that is a large concern to some services. The participant from H5 explains:

> *"We kind of modify our teachings to help those people that we know are going to have issues with change and the technology part but I don't think in a - overall it really hinders too many things."*

6.6.5 Sabotage, Misuse, Abandonment, etc.

Some paramedics that have difficulty with new equipment can even damage it, or ignore orders to not use equipment, or other similar behaviours. The participant from L2 explains:

> *"Yeah, they get very frustrated with things and then they just chuck it or whatever."*

The participant from L5 explains:

> *"And [the paramedics] refuse to use the equipment, in which case then we start to have to performance manage them."*

6.6.6 Overreliance is Dangerous

There is a fear of overreliance on technology to the point where if the technology malfunctioned or misinformed a paramedic, it may cause some harm to the patient. The participant from H2 explains:

> *"I think they still get trained how to treat the patient, but I think the problem is they become too reliant on technology."*

6.7 Conclusion

The purpose of this chapter was to present the results of the qualitative phase, which answers the research question (RQ4) *What factors are associated with paramedic services' ability to innovate?* To answer this question, 11 Paramedic Leaders who participated in the first

phase participated in in-depth telephone interviews. In these interviews, they were asked questions regarding how their service innovates, what the role of paramedics' technology skills are in their innovation activities, and other related topics. Participants were purposefully selected based on how they self-rated their SIP in the first phase, to ensure that a variety of participants were represented and classified as either Higher than Average Innovators or Low to Average Innovators. In all, 19 themes, 3 of which were split into subthemes, resulted from this process. The themes represented various factors and phenomena related to organizational inhibitors, organizational facilitators, paramedic-related inhibitors, and paramedic-related facilitators related to service innovation within paramedic services.

Chapter 7: Discussion and Conclusion

This chapter will examine in detail the results that were reported in Chapters 5 and 6. First, the results of the first quantitative phase, which seeks to answer the first three research questions presented in this dissertation, will be discussed. Second, the results of the second qualitative phase, which seeks to answer the fourth research question presented in this dissertation, will be discussed. Third, the results of the first two phases will be discussed in a data mixing phase to address the fifth research question. To refine the theory presented in the first phase, several propositions are discussed that can be researched in future endeavours. Fourth, the contribution to theory and methodology will be discussed. Fifth, managerial implications will be presented. Sixth, the generalization of the results of this research will be discussed. Seventh, limitations and future research will be presented, and finally, the dissertation will be summarized and concluded.

7.1 Summary of Results from the First Quantitative Phase

The purpose of the first phase of this research was to answer the following three research questions.

> *RQ1: Do the organizational abilities to reconfigure and integrate with other community partners influence the ability of the paramedic service to innovate?*
>
> *RQ2: Do IT Service Provider related capabilities influence a paramedic service's ability to innovate?*
>
> *RQ3: Do the technology-related knowledge and skills possessed by paramedics influence the ability of their respective services to innovate?*

To address these research questions, the area of paramedicine in Canada was chosen, as it is currently undergoing substantial strategic and technological change, as described in Chapter 1. This research predominantly employed two popular theoretical perspectives, as described in

Chapter 2: HICs and DCs. A theoretical model integrating the two perspectives was presented in Chapter 3. The thirteen hypotheses that comprise the theoretical model will assist in answering each of the three research questions in this phase: Hypotheses H1 and H1a will assist in answering RQ1; Hypotheses H2a, H2b, H3a and H3b will assist in answering RQ2; and H4a, H4b, H5a, H5b, H6a, H6b and H6c will assist in answering RQ3. These hypotheses were tested with a dataset containing a sample of 43 Canadian paramedic services, using WarpPLS 5.0. The methodology that was used to test these hypotheses is described in the first phase of the mixed methods methodology in Chapter 4 and the results are described in Chapter 5. The results of these hypotheses tests are explained below. Since this model utilizes a multilevel approach and higher order construct structure, the results of the necessary factor analysis, emergence and assurance of sufficient lower order construct loadings are also explained.

7.1.1 Hypotheses 1 and 1a

Hypothesis 1 refers to the impact that DC has on SIP, and Hypothesis 1a refers to how the degree of integration among community partners may amplify the relationship between DC and SIP. The Hypothesis 1 test yielded a path coefficient of 0.627 ($p < 0.001$) and large effect size of 0.480 (Cohen, 1988), supporting that hypothesis. Hypothesis 1a, which posited that the degree of integration among various relevant community partners, such as social services or a hospital, moderated the relationship between DC and SIP was not significant ($p > 0.05$), therefore it cannot be supported.

7.1.2 Hypotheses 2a and 2b

Hypotheses 2a and 2b refer to the impact of Relationship Infrastructure, an IT Capability referring to the quality of relationship between the IT provider and the organization, on the

Sensing and Integrating Capabilities of the firm, respectively. Hypothesis 2a was not significant ($p = .11$) therefore it could not be supported. Hypothesis 2b was significant ($p = .03$), and yielded a path coefficient of .263 with a small effect size ($f^2 = 0.085$). Hypothesis 2b, which posits that Relationship Infrastructure impacts Integrating Capabilities of the organization, is supported.

7.1.3 Hypotheses 3a and 3b

Hypotheses 3a and 3b refer to the impact of IT Business Expertise, an IT Capability referring to the degree of knowledge that the IT provider has regarding the business context, on the integrating and coordinating capabilities of the firm, respectively. Hypothesis 3a was not significant ($p = .419$), therefore it could not be supported. Hypothesis 3b was significant ($p = 0.014$) and yielded a path coefficient of 0.305 and a small effect size ($f^2 = .142$). Hypothesis 3b, which posits an impact of IT Business Expertise on the Coordinating Capability of the organization, is supported.

7.1.4 Hypothesis 4a and 4b

Hypothesis 4a and 4b refer to the impact of group-level TAC on Sensing and Learning Capabilities, respectively. The testing of Hypothesis 4a yielded a non-significant result ($p = 0.163$) therefore it could not be supported. The testing of Hypothesis 4b produced a significant result ($p = 0.003$) with a path coefficient of 0.379 and a medium effect size of 0.156. Therefore, Hypothesis 4b, which posited an impact of group-level TAC on Learning Capabilities, is supported.

7.1.5 Hypotheses 5a and 5b

Hypotheses 5a and 5b posit that group-level IPC have an impact on Sensing and Learning Capabilities, respectively. Both hypotheses could not be supported, yielding significances of $p = 0.342$ and $p = 0.241$ respectively.

7.1.6 Hypotheses 6a, 6b and 6c

Hypotheses 6a, 6b and 6c posit that group-level UWT impacts Sensing, Integrating and Coordinating Capabilities, respectively. Testing Hypothesis 6a yielded a significant result ($p < 0.001$) with a path coefficient of 0.565 and a medium effect size of 0.332, therefore this hypothesis can be supported. Hypothesis 6b cannot be supported, as its testing resulted in non-significance ($p = 0.117$). Hypothesis 6c test was significant ($p < 0.001$) with a path coefficient of 0.462 and medium effect size of .263, therefore it can be supported.

7.1.7 Addressing Research Question 1

The purpose of the first research question is to determine the influence of the DCs and integration with other services on their SIP. DC was modelled as a higher order construct, that was comprised of the Sensing, Learning, Integrating and Coordinating Capabilities. This model can be classified as “reflective-formative”, or “type II”, where the higher order construct is conceptualized as a formative latent variable, and the lower order constructs that comprise it are all reflective. It was estimated using the two-stage method (Ringle et al., 2012; Wetzels et al., 2009), which involves estimating latent variables for the lower-order constructs, and applying those latent variable estimations as manifest variables to the higher-order construct in a reflective manner. All four lower order constructs were significantly related to the higher order construct (Sensing Capabilities path coefficient = 0.296, $p = 0.017$; Learning Capabilities path coefficient

= 0.3, p = 0.016; Integrating Capabilities path coefficient = 0.278, p = 0.023; Coordinating Capabilitiesa path coefficient = 0.272, p = 0.026).

The hypothesized relationship between DCs and SIP was strongly supported, and this is a finding that is found elsewhere in the literature (Pavlou & El Sawy, 2011; Chen & Chang, 2013). Integration among community partners as a moderator of the relationship between DC and SIP was not supported in this research. Integration in this sense captured a broad degree of activities, including information sharing, joint strategic planning, and day-to-day operations. The moderating hypothesis was shy of attaining significance (p = 0.067 > 0.05). The researcher believes that this hypothesis, although not supported in this research, is still important, potentially attainable, and perhaps would be supported under certain conditions.

7.1.8 Addressing Research Question 2

The purpose of the second research question was to determine the role of the relationship between the organization and its IT provider in influencing DCs. The two IT Capabilities used in the model were chosen as they speak to a higher understanding that is often needed by management professionals when dealing with issues within the complex context of healthcare in particular (Currie & White, 2012). The IT Capabilities were modelled as direct antecedents to the lower order constructs that comprise DC, rather than to the higher order construct of DC itself, as recommended by Cadogan & Lee (2013).

These constructs are significant antecedents of some of the dimensions of DCs, which generally indicate the importance of the IT department or contractor. Relationship Infrastructure, the degree of quality of the relationship between the IT provider and the Paramedic Leader, has been shown to be a significant predictor of Integrating Capabilities. The most likely explanation

is that knowledge and information exchange between IT and paramedic leaders facilitates developing greater understanding for issues when a collective sense of the changes is being made. Taken with the insignificant impact on Sensing Capabilities, this relationship is utilized by the paramedic leader is valuable *when the organization is selecting and communicating planned change, but it is not an important resource for learning about new innovations*.

IT Business Expertise, speaking to the knowledge that the IT provider staff has about the business context, is a significant antecedent to Coordinating Capabilities, and not a significant antecedent to Integrating Capabilities. The likely explanation is that interaction between paramedics and IT staff matters are most involved *when system changes are actually happening*. However, when a collective sense is being made by the members of the organization, the IT staff may not have a bearing.

7.1.9 Addressing Research Question 3

The intention of the third research question was to determine impact of group level HICs on the ability of organizations to innovate. This knowledge was measured by using group-level estimations of HIC factors, and the ability of the organization to change and be successful at innovating, as seen through the theoretical lens of DC (Teece, 2007). This theorization is derived from various approaches that view the knowledge of individuals as essential resources to the firm (eg. Grant, 1996; Ployhart & Moliterno, 2011; Teece, 2007). An abductive approach (Haig, 2005a), where methods such as EFA takes place *a priori*, aided the investigation by allowing the detection of factors among the competency items while developing hypotheses. Referring to approaches that view individual knowledge as a contributor to organizational capabilities (Ployhart & Moliterno, 2011; Grant, 1996b; Teece, 2007), the collection of this data was

justified. To estimate the group level HIC at each paramedic service, three steps were taken. First, paramedics at each service answered instruments containing HIC items. Second, this data was subjected to EFA to detect factors. Three factors emerged through EFA on the HIC data. These factors were subsequently labeled "Technology Application Competencies", "Information Processing Competencies" and "Understanding of the Workings of Technology". Third, the emergence of these factors to the group level was detected using r(wg) and ICC statistics. Although the r(wg) statistics were acceptable (> 0.7), the ICC statistics were low. Despite this limitation, analysis proceeded due to the strong within-group agreement statistic, as the weak ICC statistic may be attributed to a naturally-occurring wide variability with respect to service size across Canada. The group level HICs were then modelled as direct antecedents to the lower order constructs that comprise DC, rather than to the higher order construct of DC itself, as recommended by Cadogan & Lee (2013).

The support of Hypotheses H4b, H6a, H6c, supplemented by some of the results in the post-hoc analysis, suggest that group-level HICs can affect DCs, in a general sense. Several of these hypothesis, specifically H4a, H5a, H5b and H6b, were not supported. These findings generally suggest that *some competencies shared among paramedics support some capabilities more than they do others*.

The factor labeled TAC captured the group-level competencies associated with identifying opportunities with technology, and was significantly related to Learning Capabilities. This finding supports the notion that the ability for workers to identify opportunities for improvement with technology will assist when relevant models for potential improvement are being contextualized to the organization. The factor labeled UWT captured some rudimentary

understanding of commonly used technology, and was significantly related to Sensing and Co-ordinating Capabilities. This suggests that organization members understanding of how technology works will assist organizations in detecting potential models or technologies that can potentially improve operations. As well, when solutions are eventually implemented, individual knowledge will facilitate the deployment of people and resources to new processes. Taken together, some knowledge on how technology works, along with the ability to identify opportunities for improvements with technology, mirror the two activities found in previous research on DCs when applying IT in healthcare (Singh et al., 2011). In particular, both competencies would be needed *when appraising technology in relation to a particular healthcare process.*

The IPC factor seems to have no significance in this context, as it appears that performing research on topics, presenting information, and associated tasks are neither a normal part of the paramedic's work duties, nor do they contribute to organizational innovation (this point will be discussed more in depth below).

7.2 Summary of Results from the Second Qualitative Phase

The purpose of the second phase is to answer the following research question:

> *RQ4: What factors are associated with paramedic services' ability to innovate?*

To answer this question, a qualitative phase (described in Chapter 4 – Methodology) sought to explore factors which influence the ability of the organization to innovate. The spirit of this intentionally broad research goal is to gain a rich yet wide perspective of how innovation takes place in these organizations, and the influence of technology and technological skills of the organization members. To accomplish this goal, in-depth interviews were conducted with a

select number of participants from the first phase. This phase yielded several findings that increase understanding of innovation in healthcare, and the role of technology in this innovation. In all, 19 themes, 3 of which are further organized into subthemes, were extracted in this phase.

7.2.1 Organizational Factors - Use of ePCR

One major finding of this phase pertains to the importance of the ePCR for organizations. ePCRs are technologies in which paramedics enter data for each call they are dispatched on. It typically contains clinical information regarding the medical condition of the patient, as well as some operational information. Paramedic services are mandated to report much of this information to various overseeing bodies, and results from this phase indicate that there is a clear benefit with electronic records over paper based PCRs for both collecting and reporting this data. Besides that, the data stored in such systems seem to be at the core of many quality improvement initiatives in the organizations that possess them. Reports from ePCRs are used most importantly to discover trends and direct clinical skill development for their paramedics. They also help to direct a variety of operational improvements, justify technology purchases, support participation in studies, and many other uses. The Paramedic Leaders seem to put a lot of trust in the reports that come out of these systems, and they seem to use them frequently and are quite familiar with them. The four participants in this phase that had not adopted an ePCR at the time of this study were effectively prevented from participating in any activities that are commonly part of normal operations for sites that have adopted an ePCR. Despite this, there is a strong desire to adopt these systems, and an awareness of how the data from this system will be used, and the benefits that they entail.

7.2.2 Organizational Factors - Governance

Another strong theme that emerged from this research is the impact that the governing bodies have on innovation in a paramedic service. There seems to be a normal process to achieving approval for projects, which often involves these governing bodies, whether they be a municipality, regional health authority, or otherwise. Indeed, this seems to be related strongly to the inability to achieve funding to adopt an ePCR. Projects must be justified before funding is allocated, benefits to patient care must be demonstrated, consultations and pilot studies must take place, change must be managed, support for paramedics must be in place, and so on. For some of these services, there is a feeling that this process is overly restrictive, and not funding certain technologies (such as an ePCR) prevents the service from taking part in the various aforementioned quality improvement activities. This presents a difficult situation for Paramedic Leaders. Other than governing bodies, support for innovations must usually be gained from other departments (i.e. the IT department), physicians, base hospitals, and other similar stakeholders. As well, the Paramedic Leaders anticipate in the future a stronger infrastructure for both project support and remote wireless data communications technology.

7.2.3 Paramedic Factors

Regarding paramedic factors, it seems that Paramedic Leaders do regard the ability to use technology as an important competency for this field. According to the themes discovered in the second phase, the service benefits from these skills in several ways. First and foremost, it seems that this skillset is important especially when a technology is being adopted by a paramedic service. During implementation, paramedics with better technological skills will assist in helping lower skilled paramedics learn the technology. Sometimes, age can be a factor that is related to

the paramedic's ability to adopt and use technology. To complement formal training programs, paramedics with difficulty adopting a technology may be paired up with a paramedic with more advanced technology skills for a few shifts, or special attention may be given to paramedics in other similar ways. This seems to be a resource-light, ad hoc, and most importantly, effective method to ensure that the technology is used effectively by all paramedics in the organization. Apart from supporting new technologies, the paramedics are often seen as a source of new ideas for the firm. Both the experience in the paramedic context and the knowledge of technology are seen as the "two ingredients" needed for innovation, echoing the findings of Singh et al. (2011), as well as the findings from the first phase of the study. Both of these findings suggest that technology is adopted throughout a paramedic service in a diffusing pattern similar to that described by Rogers (2003). According to Rogers, a small group of innovators champion innovations, and so-called late adopters and laggards will eventually use the innovation, in a seemingly ad hoc style of support available for this group. In general, the abilities for paramedics to think on their feet, be creative and visionary, and contribute new ideas in a positive manner are valued traits in the eyes of Paramedic Leaders.

A pattern of innovation adoption is shared among paramedic services which by and large adopt innovation in a pattern that is reflective of Rogers' theory, where individuals termed innovators and early adopters will use the innovation earlier, and late adopters and laggards later. Forms of support may include a learning intervention, taking the technology home so the paramedic can learn during downtime, or pairing a late-adopter partner up with an advanced user for a time. In all groups, it seems that there is not a shortage of ideas coming into the organization from both leaders and paramedics. In both groups, only a small number, estimated

by some at about 5-10% of the paramedics in the group in some cases, contribute to the implementation of these new ideas, which normally come from outside the service through research and personal interest. In rare times of direct resistance to technology or change, disciplinary measures are taken by the leadership. This seems to be a sufficient approach that is largely but not exclusively driven by a common desire to advance the capability of community paramedicine. The differences between Higher than Average Innovators and Low to Average Innovators may rest in the *degree of participation and resources* that paramedics have available in a diverse variety of activities directed at adopting innovation, including seeking out new knowledge and technology. These activities might include taking on pet projects, interacting with communities outside of the paramedic service, and a diverse array of other activities.

7.3 Summary of Results from the Mixing Phase and Propositions

The purpose of this section is to answer the following research question:

> *RQ5: How do the quantitative and qualitative data together reveal approaches to improving the ability of a paramedic service to innovate?*

As explained in Chapter 1, the purpose of this question is to gain insights by blending the inferences gained from the quantitative and qualitative phase. More specifically, the purpose of the second phase was to expand on the results of the first quantitative phase. To answer this question, the results from the quantitative and qualitative phases are interpreted together in order to discover any further insight that would not have been discovered when the results are interpreted separately. The purpose of this phase is to generate *meta-inferences* developed from a combination of results from the previous two phases. Meta inferences are “theoretical statements, narratives, or a story inferred from an integration of findings from quantitative and qualitative strands of mixed methods research” (Venkatesh et al., 2013, p.38). The development of meta

inferences are characteristic of mixed methods research, as this is one stage in which the "mixing" occurs. In sequential explanatory mixed methods studies, this phase typically occurs in the Discussion section, after the data from the quantitative and qualitative phases have been interpreted separately (Venkatesh et al., 2013; Creswell & Plano Clark, 2011). It is not necessary that these two phases yield inferences that are consistent or confirm each other (Tashakkori & Teddlie, 2010, chap.26). The meta inferences in this section are presented thematically and generated with a weaving approach (Fetters et al., 2013), which entails writing quantitative and qualitative findings together, grouped within the same themes or concepts. Finally, to fulfill the purpose of sequential explanatory mixed methods research to refine the original theoretical model (Creswell & Plano Clark, 2011), propositions will be presented from each of the findings in this section.

7.3.1 Knowledge Absorption

The results from the qualitative phase suggest that the ePCR data is either relied upon or desired by the paramedic leadership. Many of the leaders use this data to improve clinical performance by directing educational and other interventions among the paramedics. There seems to be a consistent pattern of periodically auditing the ePCR data, deciding and implementing an intervention, and monitoring for changes. In this research, the service innovation performance construct represented the ability of the paramedic service to develop new service delivery models. However, not all of the paramedic services' efforts to use ePCR data can be categorized as service innovation efforts, although they likely have a significant impact. Many of these applications of the ePCR data could be classified as process innovation, which entails the introduction of new procedures into an organization's task domain (Zmud,

1982) in order to improve internal capabilities (Johne, 1996). Applied to clinical areas, process innovation may entail enhancement of existing clinical processes using new evidence and technology (OECD, 2013).

Absorptive capacity has been used as a theoretical lens to understand how technology applied in healthcare can enable this type of innovation. These organizational routines that comprise absorptive capacity are seen by some as essential to properly take advantage of the knowledge that is generated from organizational IT (Malhotra et al., 2005; Joshi et al., 2010). Absorptive capacity is defined as an organizational capability that is concerned with applying external knowledge within the firm (Zahra & George, 2002; Cohen & Levinthal, 1990; Malhotra et al., 2005), although knowledge generated from firm technology has also been considered (Joshi et al., 2010; Malhotra et al., 2005). It comprises potential and realized absorptive capacity. Potential absorptive capacity includes organizational processes associated with acquiring knowledge and assimilating knowledge so that it is understood (Zahra & George, 2002). Realized absorptive capacity entails transforming routines for the incorporation of new knowledge in existing processes, and exploiting knowledge by creating and extending operational competencies (Zahra & George, 2002; Cohen & Levinthal, 1990). In the healthcare context, absorptive capacity is increasingly used to explain varied aspects of adoption and use of EMRs and other organizational level technologies in healthcare. In particular, it has been used to explain the meaningful use of an EHR (Wu et al., 2015), and EMR implementation as a transformative intervention in healthcare settings (Kash et al., 2013).

Although absorptive capacity is important for using EMRs to drive innovation, there are several IT capabilities that, along with absorptive capacity, are essential in ensuring that

technologies can be properly capitalized upon (Grant, 1996a; Rai & Tang, 2010). One application involves the utilization of the knowledge generated by these organizational technologies created by business analytics endeavours. As such, several researchers have proposed IT Capabilities related to analytics activities, although no dominating paradigm for business analytics capabilities currently exists. Holsapple, Lee-Post & Pakath (2014) propose that this would entail the capability to use quantitative and qualitative statistical techniques, various technologies, analysis techniques and use of insight, although conceptual clarification is needed to reflect any phenomena related to analytics competencies. Other factors, including data governance (LaValle et al., 2010) and data driven culture (Kiron et al., 2012) have also been considered for inclusion for this developing concept.

Considering the general pattern of innovation that is undertaken by paramedic services, and the literature, absorptive capacity and IT capabilities seem to be important for process innovation. Current theoretical models have proposed that absorptive capacities are mediators to various capabilities and performance (eg. Liu et al., 2013; Tzokas et al., 2015), mediator between IT capabilities and innovation (Limaj et al., 2016), and directly antecedent to innovation performance (Raymond et al., 2015). These researchers take the view that absorptive capacity is a *moderator* between business analytics capabilities and process innovation performance, for the following reason. The business analytics capabilities will largely be related to the features of the tools of the ePCRs that paramedic leaders choose to adopt, which already include some reporting and analytics functions. The tools will likely generate knowledge that will lead the paramedic leadership to some improvement, but this effect should be enhanced by the organization's ability to absorb that knowledge. Specifically, potential absorptive capacity will enhance the ability to

acquire knowledge from *internal* sources (i.e. ePCRs) and understanding results of data analysis in the context of organizational activities. Realized absorptive capacity will then enhance the ability of an organization to change a process, especially when resources acquisition, policy or other similar factors are involved. Other researchers have suggested that this may related to dynamic, information technology, or operational capabilities (Holsapple & Whinston, 1996). Considering this, the following is proposed:

> *Proposition 1: Analytics-related competencies is an organizational capability that includes the ability to use relevant analytic technologies and techniques, gain insight from data, and identify areas and approaches for process intervention. Both potential and realized absorptive capacity will moderate (amplify) the relation between these analytics related competencies and process innovation.*

7.3.2 Understandings of the Workings of Technology

The group-level factor labeled UWT was shown to impact organizational level Sensing Capabilities (Hypothesis 6c) significantly. This capability pertains to the organization's ability to detect changes in the environment that are significant to the organization. In this case, these changes can include changes to new technological developments that may impact paramedicine practice. The results of the second phase of the study seems to generally support the notion that paramedics who are more technologically inclined more often present new ideas to the leadership, spread information within the organization about new ideas, and participate in knowledge sharing among paramedics in other organizations. The items that are captured within the UWT factor relate primarily to Internet usage-related skills, and don't quite capture the breadth of technology available in the market, such as smart phones, tables, and a variety of apps and devices useful to paramedics. As the HIC items were not constructed in the normally consultative way (e.g. Curran, 2003), but were adapted from a different area, this conceptual gap

could mean that *such a concept would likely capture a wider breadth of understanding of the workings of technology*. Skills that have been mentioned in the second phase include the use of personal mobile devices, apps, tablets, various devices as well as the ability to understand devices and apps on the fly, and using more than one device simultaneously. Therefore, it can be proposed:

> *Proposition 2: The Understanding of the Workings of Technology factor will capture competencies related to spontaneous use of technology, the ability to learn apps, to use smart phones and tablets, using multiple devices simultaneously, and other similar competencies.*

7.3.3 Technology Application Competencies

The group-level factor labeled Technology Application Competencies was shown to impact organizational level Learning Capabilities (Hypothesis 4c). This notion is largely confirmed by the results of the second phase. Learning Capabilities refer to the ability of an organization to apply new knowledge to existing routines, and it follows that paramedics must have some level of contextual knowledge of their day-to-day duties to understand how technology can be employed to improve it. One result in the second phase indicates that there may be another factor that will bear on the changing of the routines earlier on in the innovation process. The *ability of paramedics to think creatively may also impact Learning Capabilities* has been identified as an important ingredient for this process, as well as a focus for paramedic training and development. The ability to think creatively may serve an important function in this situation. Whereas knowledge of technology and its applications may be general, and knowledge of the day-to-day is also necessary, creativity may serve a purpose in producing ideas on *how* a technology can be *adapted for local conditions.* Therefore, it can be proposed:

Proposition 3: Group-level competencies that capture factors related to creative thinking will positively impact the Learning Capabilities of the paramedic service.

7.3.4 IT Governance and its Relationship to Performance

One important finding rests in the use of ePCRs. As demonstrated above, the services that have adopted ePCRs experience many benefits from efficiency and the ability to engage in a greatly enhanced quality improvement initiative. The services that haven't yet adopted ePCRs are aware of the benefits and how they would be used, yet are frustrated that they can't receive this technology. As demonstrated in the results of the second phase, there is a strong relationship between adoption of ePCR and performance among participating paramedic services; those who have adopted it view themselves as more able to innovate in relation to their peers. This calls into question the process surrounding adoption of innovation and technology that involves the bodies that govern paramedic services. IT Governance can be considered an organizational mechanism that is concerned with the selection of IT projects, along with executive support, and involvement in strategic processes, as well as other factors, and its link with organizational performance (eg. Luftman & Brier, 1999). Of course, healthcare organizations have indicators of performance that differ from other organizations. They are concerned with performance, but at the same time, patient safety and health outcomes, so "Healthcare IT Governance" may take on several more factors that encompass clinical and other relevant factors, in a fashion that is understandable to administrators. Finally, although some researchers have studied IT Governance in hospitals and other healthcare environments (eg. Xue et al., 2008), an overarching theory that encompasses the adoption of innovative technology in a healthcare environment is not known by this researcher to exist.

Proposition 4: The nature of processes surrounding IT Governance in healthcare will positively influence Service Innovation Performance.

7.3.5 Integration among Partners

The results regarding the importance of integration with other agencies are conflicting. The hypothesis related to the integration that the service has with other community partners (Hypothesis H1a) did not receive support. It was not significant at the 0.05 threshold, but a marginal significance level of 0.067 was reported. Integration among community partners was hypothesized to be a moderator to the relationship between DCs and SIP, since it was theorized that innovation would be enhanced by integration, rather than be solely reliant on it. Despite this lack of support, integration among community partners was mentioned as a facilitator to innovation in the qualitative results. The theme labeled "Collaboration and Integration with Partner Organizations" was found in 5 of the organizations, 2 of which were in the Higher than Average Innovators group. Organizations mentioned here include police and fire services, nursing homes, and others. These two findings imply that *integration with community partners is helpful, but not vital, for service innovation in paramedic services*. In this current configuration, Hypothesis H1a may not apply, but Integration may influence the ability of the organization to develop plans (Rai et al., 2006), and to reconfigure organizational resources (Vanpoucke et al., 2014). As such, the degree of integration could be a resource that is drawn upon during activities involved in both planning and executing innovation in an organization. Therefore, it is proposed:

Proposition 5: Integration among community partners will influence the paramedic service's a) Integrating and b) Co-ordinating Capabilities

7.3.6 Encouraging Innovation by Paramedics

The sixth proposition pertains to encouraging innovation by paramedics. The quantitative results imply that HICs do indeed impact organizational capabilities. As well, different HICs impact different organizational capabilities, and some have no impact at all. As expressed in the qualitative section, all organizations generally have paramedics that will eventually adopt an innovation, as they are generally interested in new technologies, gear, and improving performance. Some sites in the high innovator group of services stand out, as their paramedics tend to undertake a variety of activities that *seek ideas to generate knowledge for the service.* These can include seeking knowledge from outside the organization, through online bulletin board participation (such as http://ems1.com), attendance at conferences, or internally, such as having a so-called "sandbox" where new ideas can be tried out. If paramedics are viewed as a valuable source of innovation, then their leaders should do more to encourage it. This may seem counter to the quantitative finding, which reports a non-significant relationship between Technology Application Competencies and Sensing Capabilities, and was intended to capture these activities by the paramedics. It could be perhaps that *these activities associated with fostering innovation through the activities of paramedicine practice, as effective as they can be, are just not widespread enough*. The focus of organizational learning (Fiol & Lyles, 1985) speaks to the degree that individual learning can bring knowledge into the organization, and the importance of organizational aspects such as culture and structure that can influence organizational learning. Organizational learning has been applied in healthcare, and has been successful in improving key outcomes such as patient safety (Edwards, 2016; Goh et al., 2013), as an example. Therefore:

Proposition 6: Availability and participation in activities focused on developing Organizational Learning in healthcare workers to innovate will positively impact DCs and SIP.

7.4 Contributions to Theory

This research makes several contributions to theory. First and foremost, the results of this research confirm that there is indeed an effect that competency shared among members of an organization has on organizational capabilities. A central tenet of several theoretical approaches places the basis of organizational-level capabilities upon the competency, knowledge, skills or other attributes possessed by the members of that organization (Grant, 1996b; Ployhart & Moliterno, 2011; Teece, 2007). Second, there is very little research known that uses HICs to measure the source of knowledge in the organization. This research demonstrates that different HICs impact the organization in different ways, and some HICs have little value. This point is significant due to the emphasis that HICs have in a variety of areas within healthcare, and nursing in particular (Staggers et al., 2002; Curran, 2003). The implication of this finding is that future competency models should consider the organization-level effects of the competencies that they measure. Third, there has been a noticeable lack of evidence of the use of DCs in healthcare, and this research suggests that this approach within healthcare does have benefits.

Some of the contributions made by this research arise from the details of the methodology. First the use of a multilevel model for linking individual knowledge to organizational capabilities is presented. This speaks to the viability of the notion of "shared knowledge" or emerging human capital (Ployhart & Moliterno, 2011) influencing the firm. Second, this research is a demonstration of using EFA in an abductive manner (Haig, 2005b). This is useful for detecting phenomena and informing researchers during the theoretical

development stage. Although EFA is not widely used in Information Systems research in this manner, it has been used elsewhere (eg. Conway & Huffcutt, 2003). Third, the findings of this research support the argument of Cadogan & Lee (2013), who argue against using higher order constructs as dependent variables. Doing so obscures information regarding the effect that an antecedent may have on a dependent variable. In this research, several of the hypotheses featuring lower order constructs as dependent variables were significant. Models in post hoc analysis suggested no relationship between that same antecedent and the higher order construct (as opposed to the lower order construct) were *not* significant. This finding supports the notion described by Cadogan & Lee (2013), where hypotheses with higher order constructs as dependent variables may obscure the true nature of the relationship between antecedents and lower-order constructs.

7.5 Managerial Implications

This research has two predominant managerial implications. The first implication concerns the technology-related competencies in front-line healthcare professionals. The results of this research underline that the knowledge and skills related to technology can influence the ability of the organization to respond to changes in their environment and innovate. In particular, the services that are higher than average include paramedics that are knowledgeable, inventive, curious, outward-looking, motivated, connected and otherwise interested in improving some aspect of their service. These individual-level aspects are actionable to varying degrees, so it would be in the interest of Paramedic Leaders, professional association members and educators to determine a direction for introducing the appropriate policy frameworks into practice. A national level policy would likely take the form of a validated and nationally adopted

competency model to guide educators when developing programs that are valuable to EMS services nationally. The National Occupational Competency Profile for Paramedics (NOCP; Paramedic Association of Canada (PAC), 2011) is intended to "create national standards for education programs, and … to provide a tool to…. establish common workplace standards and enhance labour mobility" (Preamble). This competency profile describes the core knowledge that paramedics at various levels need to possess. These competencies pertain to clinical skills, medical knowledge, communication skills, health and safety, medical diagnostics, ambulance operation and maintenance, and others. Technology, informatics or innovation-related competencies such as the ones included in this research are not prominently featured here. Future efforts might consider the inclusion of paramedic-specific HICs in the NOCP profile. Further, these HICs must truly reflect the nature of paramedic use of technology, rather than be adapted from somewhere else as needed in this research. This will be accomplished only through a large-scale consultative process. Fortunately, the Canadian Paramedic Leader community seems to be used to this process, as the NOCP has previously been updated in a similar manner.

A second managerial issue pertains to the governance of technology within paramedic services. This research has discovered that availability of information technology resources and support largely affect the ability of the service to innovate. The more innovative services have IT departments and good relationships with their governing bodies and IT vendors. On the other hand, the services that innovate less have very little IT resources, and although they are aware of the immense benefits of technology, they have difficulties in convincing administration to invest in IT resources. Often these services have to compete for funding with healthcare organizations such as hospitals and other healthcare providers for investment. The results of this study would

hopefully stimulate discourse between Paramedic Leaders and their respective professional organizations with investment decision makers at the healthcare system oversight level. The diverse group of Paramedic Leaders that have participated in this research understand clearly the benefits that common technologies such as an ePCR will have on patient care, and correspondingly the organization as well as the healthcare system. This way of thinking is the chief motivation for this research. If this way of thinking could reach more investment decision makers, the benefits of these technologies would become more widespread. This will likely happen through debate among the Canadian paramedicine and healthcare community, and the presentation of research and evidence from other studies. It is the author's intention to communicate this research to the paramedicine professional audience through available practitioner publications, such as Canadian Paramedicine, and the practitioner-oriented Journal of Emergency Medical Services.

7.6 Generalizability

Generalization of research involves making broad inferences regarding the applicability of research to different contexts (Lee & Baskerville, 2003). Although some characteristics of this study are commonly associated with limited generalizability – such as small sample size and non random sampling – an argument can still be made that this research is generalizable to some degree. Other-settings generalizability (Seddon & Scheepers, 2006) claims that the *representativeness* of the sample can be used as a basis for these arguments. It is argued that this research can be applied to other paramedic services in Canada and other developed nations, due to the diversity of paramedic services involved with respect to their service innovation performance and technology adoption and use. Many jurisdictions and health systems across the

developed world are seeing a transformation of their paramedic services in this manner. Ones who are not going through these technological and operational changes are likely aware of these new technologies and service delivery models, as are several of the paramedic services that have participated in this study. Indeed, this research includes sites that are both under transformation, and ones that are not.

7.7 Limitations and Future Research

This paper has acknowledged several limitations, and these have been articulated throughout the paper. First, the Intraclass Correlation statistics could not on their own be used to justify aggregation of the paramedic HICs to the group level. Second, the Fornell-Larcker (1981) criterion which determines discriminant validity between Service Innovation Performance and Learning Capability could not be clearly demonstrated. In the intermediate phase, the effective difference between Low to Average Innovators and Higher than Average Innovators is marginal in the Likert scale answers on the Service Innovation Performance items.

Besides the aforementioned statistical shortcomings, this paper has some other limitations which may stimulate further research. First, a systematic approach to the literature review may have more thoroughly informed the theoretical basis for this research, compared to the thematic approach that was used here. Second, the competency model that was used in this research was originally developed for public health practitioners rather than paramedics. Due to the smaller scale of this study, an adaptation of a pre-existing competency model was chosen, rather than developing an entirely new one for paramedics, as such processes are often lengthy, and it was recommended that this should be avoided by multiple medical practitioners. This study provides guidance as to what should be contained in such a competency model. However, this research

could be used as a starting point for a competency model within paramedicine that captures the necessary skills and knowledge needed to use innovative technologies in this field. A related issue concerns the use of a single EFA phase to discover the HIC factors. Other approaches to factor analysis utilize a two sample approach, where the factors are discovered in one dataset, and then confirmed with Confirmatory Factor Analysis (CFA) in either another dataset or with a portion of one dataset. These approaches, despite offering increased validity to the resulting factors, were impractical to implement for a few reasons. Collecting two datasets of HICs from paramedics would require permission from their Paramedic Leaders regardless if data was collected at the organization level, and whichever sites were collected at the beginning could not be predicted, and cannot be considered sufficiently representative of the whole. The dataset could not be split in this application, as all paramedic participant results were needed to be used in further multilevel analysis. As well, the validity of the factors would ultimately be limited considering that the instrument was not created originally for paramedics, therefore any benefit that the use of methods beyond EFA could provide would be questionable.

Third, this study was composed of self-selected participants. As this study involved the technology related topics, this may have discouraged both paramedics and Paramedic Leaders that are averse to technology or believe it will not benefit their practices. This may translate into a bias that could possibly affect the results. Fourth, a more representative study inclusive of more jurisdictions in Canada was not possible, as permission to research in some provinces could not be secured. Therefore, this study is not entirely representative of paramedicine practice across Canada. Fifth, some opportunity exists to study phenomena at both levels of analysis. For instance, the paramedic perception of organizational phenomena may be different than the

perception of the Paramedic Leader. For example, paramedics may perceive the degree to which the organization is integrated with other organizations or the expertise of the IT staff differently than a Paramedic Leader would perceive it.

7.8 Conclusion

The purpose of this dissertation is to determine the role of paramedic HICs have on the innovativeness of the organization. To achieve this purpose, multilevel research involving 502 paramedics from 43 Canadian land-based paramedic services was undertaken. This research integrates two main theoretical views: that of HICs, representing the technology-related knowledge and skills of the paramedic, and DCs, representing the ability of an organization to adjust to changing environments.

Generally, the results of this study support the notion that individual competencies will impact organizational capabilities, although not all competencies were important to organizational innovation, and competencies could support DCs at either the early or late phases of innovative change. Important factors that differ between high-innovating and low-innovating paramedic services emerged from qualitative reviews. The presence of an ePCR seemed to be a key resource that is used for identifying areas for clinical skill improvement, as well as the timely generation of reports that are used to justify investment. High-innovators provide more opportunities for knowledge generation activities for their paramedics, and some Lower to Average Innovators are inhibited by lack of financial support from their governing bodies. Future directions for research include the development of a tiered informatics competency model for Canadian paramedics, and developin

g the concept of IT governance specifically for healthcare organizations.

List of References

Adams, G.L. et al., (2006) 'Effectiveness of Prehospital Wireless Transmission of Electrocardiograms to a Cardiologist Via Hand-Held Device for Patients With Acute Myocardial Infarction (from the Timely Intervention in Myocardial Emergency, NorthEast Experience [TIME-NE])'. *The American Journal of Cardiology*, Vol. 98 No. 9, pp.1160–1164. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0002914906013543 [Accessed June 21, 2016].

Alberta Health Services (AHS), 'Emergency Medical Services FAQs'. Available at: http://www.albertahealthservices.ca/assets/about/ems/ahs-data-ems-faq.pdf [Accessed June 22, 2016].

American Nurses Association (ANA), (2015) *Nursing Informatics: Scope and Standards of Practice*, Silver Spring, MD, USA. Available at: http://nursesbooks.org.

Aminzadeh, F. & Dalziel, W.B., (2002) 'Older Adults in the Emergency Department: A Systematic Review of Patterns of Use, Adverse Outcomes, and Effectiveness of Interventions.'. *Annals of Emergency Medicine*, Vol. 39 No. 3, pp.238–247.

Ammenwerth, E. et al., (2003) 'Factors Affecting and Affected by User Acceptance of Computer-Based Nursing Documentation: Results of a Two-Year Study.'. *Journal of the American Medical Informatics Association*, Vol. 10 No. 1, pp.69–84.

Andreev, P. et al., (2009) 'Validating Formative Partial Least Squares (PLS) Models: Methodological Review and Empirical Illustration'. In *ICIS 2009 Proceedings*. Phoenix, Arizona, USA. Available at: http://aisel.aisnet.org/icis2009/193 [Accessed June 7, 2016].

Antony, J. et al., (2012) 'Application of Six Sigma DMAIC methodology in a transactional environment'. *International Journal of Quality & Reliability Management*, Vol. 29 No. 1, pp.31–53. Available at: http://www.emeraldinsight.com/10.1108/02656711211190864 [Accessed January 31, 2012].

Arocha, J.F. & Hoffman-Goetz, L., (2012) 'A Survey of Public Health and Consumer Health Informatics Programmes and Courses in Canadian Universities and Colleges'. *Informatics for Health & Social Care*, Vol. 37 No. 4, pp.242–252. Available at: http://www.tandfonline.com/doi/abs/10.3109/17538157.2011.647937 [Accessed May 17, 2016].

Auditor General of Ontario (AGO), (2013) *2013 Annual Report of the Office of the Auditor General of Ontario (Chapter 3)*, Toronto, ON, Canada. Available at: http://www.auditor.on.ca/en/content/annualreports/arreports/en13/300en13.pdf.

Ayres, E.J. et al., (2012) 'Nutrition Informatics Competencies across All Levels of Practice: A National Delphi Study'. *Journal of the Academy of Nutrition and Dietetics*, Vol. 112 No. 12, pp.2042–2053. Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3652246&tool=pmcentrez&rendertype=abstract [Accessed April 11, 2016].

Bachiochi, P.D. & Weiner, S.P., (2004) 'Qualitative Data Collection and Analysis'. In Steven G. Rogelberg, ed. *Handbook of Research Methods in Industrial and Organizational Psychology*. Malden, MA, USA: Blackwell Publishing.

Bagozzi, R.P. & Yi, Y., (1991) 'Multitrait-Multimethod Matricies in Consumer Research'. *Journal of Consumer Research*, Vol. 17 No. 4, pp.426–439.

Bakken, S., (2001) 'An Informatics Infrastructure Is Essential for Evidence-based Practice'. *Journal of the American Medical Informatics Association*, Vol. 8 No. 3, pp.199–201. Available at: http://jamia.bmj.com/content/8/3/199.full [Accessed March 14, 2014].

Ball, L., (2005) 'Setting the Scene for the Paramedic in Primary Care: A Review of the Literature.'. *Emergency Medicine Journal*, Vol. 22 No. 12, pp.896–900.

Barney, J., (1991) 'Firm Resources and Sustained Competitive Advantage'. *Journal of Management*, Vol. 17 No. 1, pp.99–120.

Bartlett, M.S., (1954) 'A Note on the Multiplying Factors for Various $\chi 2$ Approximations'. *Journal of the Royal Statistical Society (Series B)*, Vol. 16 No. 2, pp.296–298.

Bassellier, G. & Benbasat, I., (2004) 'Business Competence of Information Technology Professionals: Conceptual Development and Influence on IT-Business Partnerships'. *Management Information Systems Quarterly*, Vol. 28 No. 4, pp.673–694.

Becker, G.S., (1964) *Human Capital*, New York, New York, USA: Columbia.

Becker, J.-M., Klein, K. & Wetzels, M., (2012) 'Hierarchical Latent Variable Models in PLS-SEM: Guidelines for Using Reflective-Formative Type Models'. *Long Range Planning*, Vol. 45 No. 5, pp.359–394.

Behrens, J.T. et al., (2003) 'Exploratory Data Analysis'. In *Handbook of Psychology*. Hoboken, NJ, USA: John Wiley & Sons, Inc. Available at: http://doi.wiley.com/10.1002/0471264385.wei0202 [Accessed June 11, 2016].

Bell, B.A., Ferron, J.M. & Jeffrey D. Kromrey, (2008) 'Cluster Size in Multilevel Models: The Impact of Sparse Data Structures on Point and Interval Estimates in Two-Level Models'. In *Joint Statistical Meetings*. Denver, CO: American Statistical Association, pp. 1122–1129.

Benamati, J. & Lederer, A.L., (2008) 'Decision Support Systems Unfrastructure: The Root Problems of the Management of Changing IT'. *Decision Support Systems*, Vol. 45 No. 4, pp.833–844.

Benner, J.P. et al., (2008) 'Information Transfer from Prehospital to ED Health Care Providers'. *The American Journal of Emergency Medicine*, Vol. 26 No. 2, pp.233–235.

Bernstein, J.A. et al., (2015) 'Ensuring Public Health's Future in a National-Scale Learning Health System'. *American Journal of Preventive Medicine*, Vol. 48 No. 4, pp.480–487. Available at: http://www.sciencedirect.com/science/article/pii/S0749379714006710 [Accessed May 17, 2016].

Berwick, D.M., (2003) 'Disseminating Innovations in Health Care'. *Journal of the Amercian Medical Association*, Vol. 289 No. 15, pp.1969–1975.

Bharadwaj, A.S., (2000) 'Resource-Based Perspective on Information Technology Capability and Firm Performance: An Empirical Investigation'. *Management Information Systems Quarterly*, Vol. 24 No. 1, pp.169–196.

Bhatt, G. et al., (2010) 'Building and Leveraging Information in Dynamic Environments: The Role of IT Infrastructure Flexibility as Enabler of Organizational Responsiveness and Competitive Advantage'. *Information & Management*, Vol. 47 No. 7–8, pp.341–349. Available at: http://www.sciencedirect.com/science/article/pii/S0378720610000674 [Accessed April 26, 2011].

Bhatt, G., (2003) 'Managing Information Systems Competence for the Competitive Advantage: An Empirical Analysis'. In *Proc. of ICIS*.

Bhatt, G. & Grover, V., (2005) 'Types of Information Technology Capabilities and Their Role in

Competitive Advantage: An Empirical Study'. *Journal of Management Information Systems*, Vol. 22 No. 2, pp.253–277.

Bierly, P. & Chakrabarti, A., (1996) 'Generic Knowledge Strategies in the U.S. Pharmaceutical Industry'. *Strategic Management Journal*, Vol. 17 No. S2, pp.123–135.

Billittier, A.J. et al., (1996) 'A Multisite Survey of Factors Contributing to Medically Unnecessary Ambulance Transports'. *Academic Emergency Medicine*, Vol. 3 No. 11, pp.1046–1050. Available at: http://doi.wiley.com/10.1111/j.1553-2712.1996.tb03352.x [Accessed June 23, 2016].

Bischoff, S. et al., (2015) 'Understanding Continuous Use of Business Intelligence Systems: A Mixed Methods Investigation'. *Journal of Information Technology Theory and Application*, Vol. 16 No. 2, pp.5–38.

Blacker, N., Pearson, L. & Walker, T., (2009) 'Redesigning Paramedic Models of Care to Meet Rural and Remote Community Needs'. In *10th National Rural Health Conference*. Canberra, ACT, Australia.

Bliese, P.D., (2000) 'Within-Group Agreement, Non-Independence, and Reliability: Implications for Data Aggregation and Analysis'. In K. J. Klein & S. W. Kozlowski, eds. *Implications for Data Aggregation and Analysis*. San Francisco, CA: Jossey-Bass, pp. 349–381.

De Boer, M., Van Den Bosch, F.A.J. & Volberda, H.W., (1999) 'Managing Organizational Knowledge Integration in the Emerging Multimedia Complex'. *Journal of Management Studies*, Vol. 36 No. 3, pp.379–398. Available at: http://doi.wiley.com/10.1111/1467-6486.00141 [Accessed September 26, 2016].

Boyatzis, R.E., (1998) *Transforming Qualitative Information: Thematic Analysis and Code Development*, Thousand Oaks, CA, USA: Sage Publications.

Braun, V. & Clarke, V., (2008) 'Using Thematic Analysis in Psychology'. *Qualitative Research in Psychology*, Vol. 3 No. 2, pp.77–101.

Browett, B., (2011) *Community Referrals by EMS (CREMS): September 2011 Report*, Hamilton, ON, Canada. Available at: http://www.hamilton.ca/NR/rdonlyres/6AB419FE-0E3C-4209-B219-0D662FC295D9/0/Sep21EDRMS_n213443_v1_HES11014_CREMS_Pilot_Project__Update.pdf.

Browett, B., (2010) *SUBJECT: Code Zero Report from January 1, 2009 to December 31, 2009 (HES10007) (City Wide)*, Hamilton, ON, Canada. Available at: http://www2.hamilton.ca/NR/rdonlyres/5E400EDE-64B5-4F10-B4F9-683BCAA06469/0/Mar24EDRMS_n84852_v1_5_1__HES10007_Code_Zero_Report_from_Jan_1_09_to_Dec_31_09_draft_4.pdf.

Brown, E. & Sindelar, J., (1993) 'The Emergent Problem of Ambulance Misuse'. *Annals of Emergency Medicine*, Vol. 22 No. 4, pp.646–650. Available at: http://www.ncbi.nlm.nih.gov/pubmed/8457089 [Accessed June 23, 2016].

Brown, L.H. et al., (2000) 'Do Warning Lights and Sirens Reduce Ambulance Response Times?'. *Prehospital Emergency Care*, Vol. 4 No. 1, pp.70–74.

Bryant, F.B. & Yarnold, P.R., (1995) 'Principal-Components Analysis and Exploratory and Confirmatory Factor Analysis.'. In L. G. Grimm & P. R. Yarnold, eds. *Reading and Understanding Multivariate Statistics*. Washington, DC: American Psychological Association, pp. 99–136.

Bureau, U.C., (2010) *Age and Sex Composition: 2010*, Washington, DC.

Burgelman, R.A., (1991) 'Intraorganizational Ecology of Strategy Making and Organizational Adaptation: Theory and Field Research'. *Organization Science*, Vol. 2 No. 3, pp.239–262.

Büschgens, T., Bausch, A. & Balkin, D.B., (2013) 'Organizational Culture and Innovation: A Meta-Analytic Review'. *Journal of Product Innovation Management*, Vol. 30 No. 4, pp.763–781.

Byrne, M. et al., (2003) 'Frequent Attenders to an Emergency Department: A Study of Primary Health Care Use, Medical Profile, and Psychosocial Characteristics.'. *Annals of Emergency Medicine*, Vol. 41 No. 3, pp.309–318.

Cadogan, J.W. & Lee, N., (2013) 'Improper Use of Formative Endogenous Variables'. *Journal of Business Research*, Vol. 66 No. 2, pp.233–241.

Cadwallader, S. et al., (2010) 'Frontline employee motivation to participate in service innovation implementation'. *Journal of the Academy of Marketing Science*, Vol. 38 No. 2, pp.219–239. Available at: http://resolver.scholarsportal.info/resolve/00920703/v38i0002/219_femtpisii.xml [Accessed October 14, 2016].

Camasso-Richardson, K., Wilde, J.A. & Petrack, E.M., (1997) 'Medically Unnecessary Pediatric Ambulance Transports: A Medical Taxi Service?'. *Academic Emergency Medicine*, Vol. 4 No. 12, pp.1137–1141. Available at: http://www.ncbi.nlm.nih.gov/pubmed/9408429 [Accessed June 23, 2016].

Campbell, D.T. & Fiske, D.W., (1959) 'Convergent and Discriminant Validation by the Multitrait-Multimethod Matrix'. *Psychological Bulletin*, Vol. 56 No. 2, pp.81–105.

Canadian Interoperability Technology Interest Group (CITIG), (2016) '700 MHz Broadband for Mission Critical Public Safety Data'. Available at: http://action700.ca [Accessed June 22, 2016].

Cardiac Care Network, (2013) *Recommendations for Best-Practice STEMI Management in Ontario*, Available at: http://www.ccn.on.ca/ccn_public/uploadfiles/files/Recommendations_for_Best_Practice_STEMI_Management_in_Ontario_(6).pdf.

Carter, L. et al., (2015) 'Exploring User Acceptance of a Text-Message Base Health Intervention among Young African Americans'. *AIS Transactions on Human Computer Interaction*, Vol. 7 No. 3, pp.110–124.

Chang, J. et al., (2011) 'Nursing Informatics Competencies Required of Nurses in Taiwan.'. *International Journal of Medical Informatics*, Vol. 80 No. 5, pp.332–340. Available at: http://www.ncbi.nlm.nih.gov/pubmed/21420902 [Accessed March 1, 2014].

Chen, Y.-S. & Chang, C.-H., (2013) 'The Determinants of Green Product Development Performance: Green Dynamic Capabilities, Green Transformational Leadership, and Green Creativity'. *Journal of Business Ethics*, Vol. 116, pp.107–119.

Chien, S. & Tsai, C., (2012) 'Dynamic Capability, Knowledge, Learning, and Firm Performance'. *Journal of Organizational Change Management*, Vol. 25 No. 3, pp.434–444. Available at: http://www.emeraldinsight.com/doi/full/10.1108/09534811211228148 [Accessed March 30, 2016].

Chin, W.W., (1998a) 'Commentary: Issues and Opinion on Structural Equation Modeling'. *Management Information Systems Quarterly*, Vol. 22 No. 1, pp.vii–xvi.

Chin, W.W., (1998b) 'The Partial Least Squares Approach to Structural Equation Modeling'. In G. A. Marcoulides, ed. *Modern Methods for Business Research*. Mahwah, NJ: Lawrence Erlbaum Associates, pp. 295–336.

Clark, C.E. et al., (1997) 'Building changereadiness capabilities in the IS organization: Insights from the Bell Atlantic experience'. *Management Information Systems Quarterly*, Vol. 21 No. 4, pp.425–455.

Cohen, J., (1960) 'A Coefficient of Agreement for Nominal Scales'. *Educational and Psychological Measurement*, Vol. 20 No. 1, pp.37–46.

Cohen, J., (1988) *Statistical Power Analysis for the Behavioral Sciences* 2nd ed., Hillsdale, NJ, USA: Lawrence Erlbaum Associates.

Cohen, J., (1968) 'Weighted Kappa: Nominal Scale Agreement Provision for Scaled Disagreement or Partial Credit'. *Psychological Bulletin*, Vol. 70 No. 4, pp.213–220. Available at: http://content.apa.org/journals/bul/70/4/213 [Accessed July 12, 2016].

Cohen, S.A., (2013) 'ePCR: A Vital QI tool. Collecting & Using Eata for EMS Quality Improvement is Easier and More Important Than Ever'. *Journal of Emergency Medical Services*, Vol. 38 No. 11, pp.58–59. Available at: http://www.ncbi.nlm.nih.gov/pubmed/24475623 [Accessed June 21, 2016].

Cohen, W.M. & Levinthal, D.A., (1990) 'Absorptive Capacity: A New Perspective on Learning and Innovation'. *Administrative Science Quarterly*, Vol. 35 No. 1, p.128. Available at: http://www.jstor.org/stable/2393553?origin=crossref [Accessed September 26, 2016].

Compeau, D.R. & Higgins, C.A., (1995) 'Computer Self-Efficacy: Development of a Measure and Initial Test'. *Management Information Systems Quarterly*, Vol. 19 No. 2, pp.189–211.

Cone, D.C., Middleton, P.M. & Marashi Pour, S., (2012) 'Analysis and Impact of Delays in Ambulance to Emergency Department Handovers'. *Emergency Medicine Australasia*, Vol. 24 No. 5, pp.525–533. Available at: http://doi.wiley.com/10.1111/j.1742-6723.2012.01589.x [Accessed June 20, 2016].

Constantine, M.G., Gloria, A.M. & Ladany, N., (2002) 'The Factor Structure Underlying Three Self-Report Multicultural Counseling Competence Scales'. *Cultural Diversity & Ethnic Minority Psychology*, Vol. 8 No. 4, pp.334–345. Available at: http://doi.apa.org/getdoi.cfm?doi=10.1037/1099-9809.8.4.335 [Accessed June 12, 2016].

Conway, J.M. & Huffcutt, A.I., (2003) 'A Review and Evaluation of Exploratory Factor Analysis Practices in Organizational Research'. *Organizational Research Methods*, Vol. 6 No. 2, pp.147–168. Available at: http://orm.sagepub.com/cgi/doi/10.1177/1094428103251541 [Accessed June 12, 2016].

Cooper, S. & Grant, J., (2009) 'New and Emerging Roles in Out of Hospital Emergency Care: A Review of the International Literature.'. *International Emergency Nursing*, Vol. 17 No. 2, pp.90–98.

Creswell, J.W., (2009) *Research Design: Qualitative, Quantitative and Mixed Methods Approaches* 3rd ed., Thousand Oaks, CA, USA: Sage Publications.

Creswell, J.W. & Plano Clark, V.L., (2011) *Designing and Conducting Mixed Methods Research* 2nd ed., Thousand Oaks, CA, USA: Sage Publications.

Cronbach, L.J., (1951) 'Coefficent Alpha and the Internal Structure of Tests'. *Psychometrika*, Vol. 16 No. 3, pp.297–334.

Crotty, M., (1998) *The Foundations of Social Research: Meaning and Perspective in the*

Research Process, London, UK: SAGE.
Crowston, K. & Kammerer, E.E., (1998) 'Coordination and Collective Mind in Software Requirements Development'. *IBM Systems Journal*, Vol. 37 No. 2, pp.227–245.
Curran, C.R., (2003) 'Informatics Competencies for Nurse Practitioners.'. *AACN Clinical Issues*, Vol. 14 No. 3, pp.320–330.
Currie, G. & White, L., (2012) 'Inter-Professional Barriers and Knowledge Brokering in an Organizational Context: The Case of Healthcare'. *Organization Studies*, Vol. 33 No. 10, pp.1333–1361.
Davis, F.D., (1989) 'Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology'. *Management Information Systems Quarterly*, Vol. 13 No. 3, pp.319–340.
Davis, F.D., Bagozzi, R.P. & Warshaw, P.R., (1989) 'User Acceptance of Computer Technology: A Comparison of Two Theoretical Models'. *Management Science*, Vol. 35 No. 8, pp.982–1003.
Davison, G. & Hyland, P., (2002) 'Pallative Care Teams and Organizational Capability'. *Team Performance Management*, Vol. 8 No. 3/4, pp.60–67.
Decter, M., (2014) 'Saving Medicare'. *Literary Review of Canada*. Available at: http://reviewcanada.ca/magazine/2014/09/saving-medicare/ [Accessed May 16, 2016].
DeLone, W.H. & McLean, E.R., (2003) 'The DeLone and McLean Model of Information Systems Success: A Ten-Year Update'. *Journal of Management Information Systems*, Vol. 19 No. 4, pp.9–30.
Desjardins, K.S. et al., (2005) 'Effect of an Informatics for Evidence-Based Practice Curriculum on Nursing Informatics Competencies'. *International Journal of Medical Informatics*, Vol. 74 No. 11–12, pp.1012–1020. Available at: http://www.sciencedirect.com/science/article/pii/S138650560500105X [Accessed May 18, 2016].
Desmond, P., (2016) 'Code Red: Ambulance Shortages Growing in Waterloo Region'. *The Record*. Available at: http://www.therecord.com/news-story/6243995-code-red-ambulance-shortages-growing-in-waterloo-region/.
Devaraj, S. & Kohli, R., (2003) 'Performance Impacts of Information Technology: Is Actual Usage the Missing Link?'. *Management Science*, Vol. 49 No. 3, pp.273–289.
Dick, W.F., (2003) 'Anglo-American vs. Franco-German Emergency Medical Services System'. *Prehospital and Disaster Medicine*, Vol. 18 No. 1, pp.29–35. Available at: http://www.ncbi.nlm.nih.gov/pubmed/14694898 [Accessed June 23, 2016].
Dixon, D.R. & Stewart, M., (2000) 'Exploring Information Technology Adoption by Family Physicians: Survey Instrument Waluation.'. In *AMIA Annual Symposium Proceedings*. Los Angeles, CA, USA, pp. 185–189. Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2243739&tool=pmcentrez&rendertype=abstract [Accessed June 12, 2016].
Dixon, M.A. & Cunningham, G.B., (2009) 'Data Aggregation in Multilevel Analysis: A Review of Conceptual and Statistical Issues'. *Measurement in Physical Education and Exercise Science*, Vol. 20 No. 2, pp.37–41.
Dohan, M.S. et al., (2014) 'EMS Dispatch Priorities: Comparing Logistic Regression Model Performance with Established Protocol'. In *Proc. of INFORMS 2014*. San Francisco, CA.

Dohan, M.S. et al., (2013) 'False Positives in EMS Call Priority Assignments: Validating Paramedic Perspectives'. In O. Seref, N. Serban, & D. Zeng, eds. *Proc. of INFORMS Workshop on Data Mining and Health Informatics (DM-HI 2013)*. Minneapolis, MN.

Doupe, M. et al., (2008) *An Initial Analysis of Emergency Departments and Urgent Care in Winnipeg*, Winnipeg, MB, Canada. Available at: http://mchp-appserv.cpe.umanitoba.ca/reference/EDFull.pdf.

Drotz, E. & Poksinska, B., (2014) 'Lean in Healthcare from Employees' Perspectives'. *Journal of Health Organisation & Management*, Vol. 28 No. 2, pp.177–195.

Drummond, A.J., (2002) 'No Room at the Inn: Overcrowding in Ontario's Emergency Departments'. *Canadian Journal of Emergency Medicine*, Vol. 4 No. 2, pp.91–97.

EagleCounty.us, (2013) 'Community Paramedic Protocols Manual'. Available at: http://ircp.info/Portals/11/Downloads/Tools/Eagle County Paramedics Community Paramedic Protocols.pdf [Accessed June 1, 2016].

Edwards, M.T., (2016) 'An Organizational Learning Framework for Patient Safety'. *American Journal of Medical Quality*, Vol. 31, p.1062860616632295. [Epub ahead of print]. Available at: http://ajm.sagepub.com/cgi/doi/10.1177/1062860616632295 [Accessed June 15, 2016].

Eisenhardt, K.M. & Brown, S., (1999) 'Patching: Restitching Business Portfolios in Dynamic Markets'. *Harvard Business Review*, Vol. 77 No. 1, pp.72–82.

Eisenhardt, K.M. & Galunic, D.C., (2000) 'Coevolving: At Last, a Way to Make Synergies Work'. *Harvard Business Review*, Vol. 78 No. 1, pp.91–101.

Eisenhardt, K.M. & Martin, J., (2000) 'Dynamic Capabilities: What Are They?'. *Strategic Management Journal*, Vol. 21 No. 8, pp.1105–1121.

Elder, E., Johnston, A.N. & Crilly, J., (2015) 'Review Article: Systematic Review of Three Key Strategies Designed to Improve Patient Flow Through the Emergency Department'. *Emergency Medicine Australasia*, Vol. 27 No. 5, pp.394–404. Available at: http://doi.wiley.com/10.1111/1742-6723.12446 [Accessed June 23, 2016].

EMS1.com, (2014) '10 Apps Every Paramedic Should Have'. Available at: http://www.ems1.com/ems-products/communications/articles/1971639-10-apps-every-paramedic-should-have/ [Accessed May 27, 2016].

EMSCC, (2011) *Provision of Telephone Advice from Accident and Emergency Departments: A National Survey*, Available at: http://www.paramedicsofmanitoba.ca/storage/Self-Regulation/Tab_2.PDF.

EMSCC, (2006) *The Future of EMS in Canada: Defining the Road Ahead*, Calgary, AB, Canada.

Epstein, I.E., Kazanjian, A. & MacAulay, D., (1998) 'Physicians and Surgeons Scope of Practice Review'. Available at: http://www.health.gov.bc.ca/professional-regulation/hpc/review/part-i/scope-physicians.html [Accessed April 20, 2016].

Eysenbach, G., (2001) 'What is Ehealth?'. *Journal of Medical Internet Research*, Vol. 3 No. 2, p.e20. Available at: http://www.jmir.org/2001/2/e20/.

Faul, F. et al., (2007) 'G* Power 3: A Flexible Statistical Power Analysis Program for the Social, Behavioral, and Biomedical Sciences.'. *Behavior Research Methods*, Vol. 39 No. 1, p.175.

Fawcett, S.E. et al., (2011) 'Information Technology as an Enabler of Supply Chain Collaboration: A Dymamic-Capabilities Perspective'. *Journal of Supply Chain Management*, Vol. 47 No. 1, pp.38–59. Available at: http://doi.wiley.com/10.1111/j.1745-

493X.2010.03213.x [Accessed May 18, 2016].
Feeny, D.F. & Willcocks, L.P., (1998) 'Core IS capabilities for exploiting information technology'. *MIT Sloan Management Review*, Vol. 39 No. 3, pp.9–21.
Felin, T., Zenger, T.R. & Tomsik, J., (2009) 'The Knowledge Economy: Emerging Organizational Forms, Missing Microfoundations, and Key Considerations for Managing Human Capital'. *Human Resource Management*, Vol. 48 No. 4, pp.555–570. Available at: http://doi.wiley.com/10.1002/hrm.20299 [Accessed August 16, 2014].
Fetters, M.D., Curry, L.A. & Creswell, J.W., (2013) 'Achieving Integration in Mixed Methods Designs—Principles and Practices'. *Health Services Research*, Vol. 48 No. 6 pt 2, pp.2134–2156.
Feufel, M.A., Robinson, F.E. & Shalin, V.L., (2011) 'The Impact of Medical Record Technologies on Collaboration in Emergency Medicine'. *International Journal of Medical Informatics*, Vol. 80 No. 8, pp.e85–e95. Available at: http://resolver.scholarsportal.info/resolve/13865056/v80i0008/e85_tiomrtociem.xml [Accessed June 20, 2016].
Fink, L. & Neumann, S., (2007) 'Gaining Agility through IT Personnel Capabilities: The Mediating Role of IT Infrastructure Capabilities'. *Journal of the Association for Information Systems*, Vol. 8 No. 8, pp.440–462.
Fiol, C.M. & Lyles, M.A., (1985) 'Organizational Learning.'. *Academy of Management Review*, Vol. 10 No. 4, pp.803–813. Available at: http://connection.ebscohost.com/an/4279103 [Accessed June 15, 2016].
Fisk, A., Berente, N. & Lyytinen, K., (2010) 'Boundary Spanning Competencies and Information System Development Project Success'. In *Proc. of ICIS 2010*. St. Louis, Missouri, USA.
Fornell, C. & Bookstein, F.L., (1982) 'Two Structural Equation Models: LISREL and PLS Applied to Consumer Exit-Voice Theory'. *Journal of Marketing Research*, Vol. 19 No. 4, pp.440–452. Available at: http://www.jstor.org/stable/3151718?origin=crossref [Accessed June 8, 2016].
Fornell, C. & Larcker, D.F., (1981) 'Evaluating Structural Equation Models with Unobservable Variables and Measurement Error'. *Journal of Marketing Research*, Vol. 18 No. 1, pp.39–50.
Frey, L.R., Botan, C.H. & Kreps, G.L., (2000) *Investigating Communication: An Introduction to Research Methods* 2nd ed., Boston, MA, USA: Allyn and Bacon.
Fuji, K.T. & Galt, K.A., (2015) 'An Online Health Informatics Elective Course for Doctor of Pharmacy Students'. *American Journal of Pharmaceutical Education*, Vol. 79 No. 3, p.41. Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=4428426&tool=pmcentrez&rendertype=abstract [Accessed May 18, 2016].
Galunic, D.C. & Eisenhardt, K.M., (2001) 'Architectural Innovation and Modular Corporate Forms'. *Academy of Management Journal*, Vol. 44 No. 6, pp.1229–1249.
Galunic, D.C. & Rodan, S., (1998) 'Resource Recombinations in the Firm: Knowledge Structures and the Potential for Schumpeterian Innovation'. *Strategic Management Journal*, Vol. 19 No. 10, pp.1193–1201.
Gardner, H.K., Gino, F. & Staats, B.R., (2011) 'Dynamically Integrating Knowledge in Teams: Transforming Resources into Performance'. *Academy of Management Journal*, Vol. 55 No.

4, pp.998–1022. Available at: http://amj.aom.org/content/55/4/998.full [Accessed March 19, 2016].

Geisser, S., (1974) 'A Predictive Approach to the Random Effect Model'. *Biometrika*, Vol. 61 No. 1, pp.101–107.

Goh, S.C., Chan, C. & Kuziemsky, C., (2013) 'Teamwork, Organizational Learning, Patient Safety and Job Outcomes'. *International Journal of Health Care Quality Assurance*, Vol. 26 No. 5, pp.420–432. Available at: http://www.emeraldinsight.com/doi/abs/10.1108/IJHCQA-05-2011-0032 [Accessed June 15, 2016].

Government of Manitoba, (2013) *Manitoba EMS System Review*, Available at: http://paramedic.ca/wp-content/uploads/2013/04/Manitoba-Final-EMS-Report-April-5-2013-F.pdf.

Grant, R.M., (1995) *Contemporary Strategy Analysis*, Oxford, UK: Blackwell Publishers Inc.

Grant, R.M., (1996a) 'Prospering in Dynamically-Competitive Environments: Organizational Capability as Knowledge Integration'. *Organization Science*, Vol. 7 No. 4, pp.375–387. Available at: http://pubsonline.informs.org/doi/abs/10.1287/orsc.7.4.375 [Accessed June 11, 2016].

Grant, R.M., (1991) 'The Resource-based Theory of Competitive Advantage: Implications for Strategy Formulation'. *California Management Review*, Vol. 33 No. 3, pp.114–135.

Grant, R.M., (1996b) 'Toward a Knowledge Based Theory of the Firm'. *Strategic Management Journal*, Vol. 17 No. 1, pp.109–122.

Green, B.N., Johnson, C.D. & Adams, A., (2006) 'Writing Narrative Literature Reviews for Peer-Reviewed Journals: Secrets of the Trade'. *Journal of Chiropractic Medicine*, Vol. 5 No. 3, pp.101–117.

Green, M. et al., (2016) 'Assessing the Impact of Nursing Informatics Competencies on Decision Making Satisfaction: Results of a Preliminary Study'. In *Proc. of AMCIS 2016*. San Diego, CA, USA.

Grgecic, D., Holten, R. & Rosenkranz, C., (2015) 'The Impact of Functional Affordances and Symbolic Expressions on the Formation of Beliefs.'. *Journal of the Association for Information Systems*, Vol. 16 No. 7, pp.580–607.

Griffith, T.L. & Sawyer, J.E., (2010) 'Multilevel Knowledge and Team Performance'. *Journal of Organizational Behaviour*, Vol. 31, pp.1003–1031.

Grobe, S.J., (1989) 'Nursing Informatics Competencies.'. *Methods of Information in Medicine*, Vol. 28 No. 4, pp.267–269.

Guadagnoli, E. & Velicer, W.F., (1988) 'Relation of Sample Size to the Stability of Component Patterns'. *Psychological Bulletin*, Vol. 103 No. 2, pp.265–275.

Guba, E.G. & Lincoln, Y.S., (2005) 'Paradigmatic Controversies, Contradictions, and Emerging Confluences.'. In N. K. Denzin & Y. S. Lincoln, eds. *The SAGE Handbook of Qualitative Research*. Thousand Oaks, CA, USA: SAGE, pp. 191–215.

Ha, B.M. & Jeong, S.R., (2010) 'Analysis of the Relationship between Corporate IT Capability and Corporate Performance through Korea IT Success Cases: An Empirical Approach'. *Asia Pacific Journal of Information Systems*, Vol. 20 No. 3, pp.91–114.

Hackman, J.R., (1987) 'The Design of Work Teams'. In J. Lorsch, ed. *Handbook of Organizational Behavior*. Englewood Cliffs, NJ: Prentice-Hall, pp. 315–342.

Haig, B.D., (2005a) 'An Abductive Theory of Scientific Method.'. *Psychological Methods*, Vol.

10 No. 4, pp.371–388. Available at: http://doi.apa.org/getdoi.cfm?doi=10.1037/1082-989X.10.4.371 [Accessed June 11, 2016].

Haig, B.D., (2005b) 'Exploratory Factor Analysis, Theory Generation, and Scientific Method'. *Multivariate Behavioral Research*, Vol. 40 No. 3, pp.303–329.

Hair, J.F. et al., (2013) *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*, Thousand Oaks, USA: SAGE.

Hair, J.F., Ringle, C.M. & Sarstedt, M., (2011) 'PLS-SEM: Indeed a Silver Bullet'. *Journal of Marketing Theory and Practice*, Vol. 19, pp.139–151.

Hansen, M.B. et al., (2014) 'Systematic Downloading and Analysis of Data from Automated External Defibrillators Used in Out-of-Hospital Cardiac Arrest'. *Resuscitation*, Vol. 85 No. 12, pp.1681–1685.

Hargadon, A. & Sutton, R.I., (1997) 'Technology Brokering and Innovation in a Product Development Firm'. *Administrative Science Quarterly*, Vol. 42 No. 4, pp.716–749. Available at: http://www.jstor.org/stable/2393655?origin=crossref [Accessed September 26, 2016].

Hart, M.D., (2008) 'Informatics Competency and Development within the US Nursing Population Workforce: A Systematic Literature Review'. *Computers, Informatics, Nursing: CIN*, Vol. 26 No. 6, pp.320–329. Available at: http://www.ncbi.nlm.nih.gov/pubmed/19047880.

Heart and Stroke Foundation, (2015) *Access to Stroke Care: The Critical First Hours*, Available at: http://www.heartandstroke.com/atf/cf/%257B99452d8b-e7f1-4bd6-a57d-b136ce6c95bf%257D/HSF_2015_STROKE_REPORT_FINAL.PDF.

Hebert, M., (2000) 'A National Education Strategy To Develop Nursing Informatics Competencies'. *Nursing Leadership*, Vol. 13 No. 2, pp.11–14. Available at: http://www.longwoods.com/content/16284 [Accessed March 1, 2014].

Helfat, C., (1997) 'Know-How and Asset Complementarity and Dynamic Capability Accumulation: The Case of R&D'. *Strategic Management Journal*, Vol. 18 No. 5, pp.239–260.

Helfat, C. & Peteraf, M., (2003) 'The Dynamic Resource-Based View: Capability Lifecycles'. *Strategic Management Journal*, Vol. 24 No. 10, pp.997–1010.

Henderson, R., (1994) 'The Evolution of Integrative Capability: Innovation in Cardiovascular Drug Discovery'. *Indistrial and Corporate Change*, Vol. 3 No. 3, pp.607–630.

Henseler, J. & Sarstedt, M., (2013) 'Goodness-Of-Fit Indices for Partial Least Squares Path Modeling'. *Computational Statistics*, Vol. 28 No. 2, pp.565–580. Available at: http://link.springer.com/10.1007/s00180-012-0317-1 [Accessed June 8, 2016].

Holsapple, C.W., Lee-Post, A. & Pakath, R., (2014) 'A Unified Foundation for Business Analytics'. *Decision Support Systems*, Vol. 64, pp.130–141.

Holsapple, C.W. & Whinston, A.B., (1996) *Decision Support Systems: A Knowledge-Based Approach*, St. Paul, Minnesota: West Publishing Company.

Hox, J., (2002) *Multilevel Analysis: Techniques and Applications*, Mahwah, NJ: Lawrence Erlbaum Associates.

Hu, P.J. et al., (1999) 'Examining the Technology Acceptance Model Using Physician Acceptance of Telemedicine Technology'. *Journal of Management Information Systems*, Vol. 16 No. 2, pp.91–112.

Hung, R.Y.Y. et al., (2010) 'Dynamic Capability: Impact of Process Alignment and Organizational Learning Culture on Performance'. *Journal of World Business*, Vol. 45 No. 3, pp.285–294. Available at: http://www.sciencedirect.com/science/article/pii/S1090951609000649 [Accessed May 18, 2016].

Hunter, K.M., McGonigle, D.M. & Hebda, T.L., (2013) 'TIGER-based Measurement of Nursing Informatics Competencies: The Development and Implementation of an Online Tool for Self-Assessment'. *Journal of Nursing Education and Practice*, Vol. 3 No. 12, pp.70–80.

Hwang, J.-I. & Park, H.-A., (2011) 'Factors Associated with Nurses' Informatics Competency'. *Computers, Informatics, Nursing: CIN*, Vol. 29 No. 4, pp.256–262. Available at: http://www.ncbi.nlm.nih.gov/pubmed/21076284 [Accessed March 1, 2014].

Hyland, P., Davidson, G. & Sloan, T., (2003) 'Linking Team Competencies to Organisational Capacities in Health Care'. *Journal of Health Organization and Management*, Vol. 17 No. 3, pp.150–163.

Isenberg, D., Cone, D.C. & Stiell, I.G., (2012) 'A Simple Three-Step Dispatch Rule May Reduce Lights and Sirens Responses to Motor Vehicle Crashes'. *Emergency Medicine Journal*, Vol. 29 No. 7, pp.592–595.

Ivankova, N. V., (2014) 'Implementing Quality Criteria in Designing and Conducting a Sequential QUAN < QUAL Mixed Methods Study of Student Engagement With Learning Applied Research Methods Online'. *Journal of Mixed Methods Research*, Vol. 8 No. 1, pp.25–51. Available at: http://mmr.sagepub.com/cgi/doi/10.1177/1558689813487945 [Accessed July 6, 2016].

Jefferies, A. et al., (2011) 'Assessment of Multiple Physician Competencies in Postgraduate Training: Utility of the Structured Oral Examination.'. *Advances in Health Sciences Education: Theory and Practice*, Vol. 16 No. 5, pp.569–577.

Jensen, R., Guedes, E. de S. & Leite, M.M.J., (2016) 'Informatics Competencies Essential to Decision Making in Nursing Management'. *Revista da Escola de Enfermagem da USP*, Vol. 50 No. 1, pp.109–117. Available at: http://www.scielo.br/pdf/reeusp/v50n1/0080-6234-reeusp-50-01-0112.pdf.

Johne, F.A., (1996) 'Avoiding Product Development Failure Is Not Enough'. *European Management Journal*, Vol. 14, pp.176–180.

Johnson, R.B., Onwuegbuzie, A.J. & Turner, L.A., (2007) 'Toward a Definition of Mixed Methods Research'. *Journal of Mixed Methods Research*, Vol. 1 No. 2, pp.112–133.

Joint Committee on Rural Emergency Care (JCREC), (2010) 'Improving Access to EMS and Health Care in Rural Communities: A Strategic Plan'. Available at: http://www.nasemso.org/Projects/RuralEMS/documents/FinalApprovedbyNASESMSO-NOSORH.pdf [Accessed May 15, 2016].

Joshi, K.D. et al., (2010) 'Changing the Competitive Landscape: Continuous Innovation Through IT-Enabled Knowledge Capabilities'. *Information Systems Research*, Vol. 21 No. 3, pp.472–495. Available at: http://pubsonline.informs.org/doi/abs/10.1287/isre.1100.0298 [Accessed May 18, 2016].

Kaiser, H.F., (1970) 'A Second Generation Little Jiffy'. *Psychometrika*, Vol. 35 No. 4, pp.401–415.

Kash, B.A., Spaulding, A. & Gamm, L.D., (2013) 'Leadership, Culture, and Organizational

Technologies as Absorptive Capacity.'. *Change Management: An International Journal*, Vol. 13 No. 1.

Katz, A., (2015) 'News: Drones: The (Possible) Future of Medicine'. *Emergency Medicine News*, Vol. 37 No. 9, p.1. Available at: http://content.wkhealth.com/linkback/openurl?sid=WKPTLP:landingpage&an=00132981-201509000-00004 [Accessed June 20, 2016].

Keen, P.G.W., (1991) *Shaping the Future: Business Design Through Information Technology*, Boston, MA: Harvard Business School Press.

Khor, M.X. et al., (2015) 'Pre-Hospital Notification is Associated with Improved Stroke Thrombolysis Timing'. *The Journal of the Royal College of Physicians of Edinburgh*, Vol. 45 No. 3, pp.190–195. Available at: http://www.ncbi.nlm.nih.gov/pubmed/26517096 [Accessed June 21, 2016].

Kim, D.H., (1993) 'The Link between Individual and Organizational Learning'. *MIT Sloan Management Review*, Vol. Fall. Available at: http://sloanreview.mit.edu/article/the-link-between-individual-and-organizational-learning/ [Accessed May 2, 2016].

Kim, G. et al., (2011) 'IT Capabilities, Process-Oriented Dynamic Capabilities, and Firm Financial Performance'. *Journal of the Association for Information Systems*, Vol. 12 No. 7, pp.487–517.

Kim, G., Shin, B. & Grover, V., (2010) 'Investigating Two Contradictory Views of Formative Measurement in Information Systems Research'. *Management Information Systems Quarterly*, Vol. 34 No. 2, pp.345–365.

Kindström, D., Kowalkowski, C. & Sandberg, E., (2013) 'Enabling Service Innovation: A Dynamic Capabilities Approach'. *Journal of Business Research*, Vol. 66 No. 8, pp.1063–1073. Available at: http://www.sciencedirect.com/science/article/pii/S0148296312000872 [Accessed February 19, 2016].

Kiron, D., Prentice, P.K. & Ferguson, R.B., (2012) 'Innovating with Analytics'. *MIT Sloan Management Review*, Vol. 54 No. 1, pp.47–51.

Kobayashi, A. et al., (2016) 'STEMI Notification by Emergency Medical Service Predicts Shorter Door-to-Balloon Time and Smaller Infarct Size'. *The American Journal of Emergency Medicine*, Vol. 34 No. 8, pp.1610–1613.

Kock, N., (2016) 'Hypothesis testing with confidence intervals and P values in PLS-SEM.'. *International Journal of e-Collaboration*, Vol. 12 No. 3, pp.1–6.

Kock, N., (2010) 'Using WarpPLS in E-collaboration Studies'. *International Journal of e-Collaboration*, Vol. 6 No. 4, pp.1–11. Available at: http://services.igi-global.com/resolvedoi/resolve.aspx?doi=10.4018/jec.2010100101 [Accessed June 8, 2016].

Kock, N., (2015) *WarpPLS 5.0 User Manual*, Laredo, TX: ScriptWarp Systems. Available at: http://cits.tamiu.edu/WarpPLS/UserManual_v_5_0.pdf [Accessed January 1, 2016].

Kock, N. & Lynn, G.S., (2012) 'Lateral Collinearity and Misleading Results in Variance-Based SEM: An Illustration and Recommendations'. *Journal of the Association of Information Systems*, Vol. 13 No. 7, pp.546–580.

Kogut, B. & Zander, U., (1996) 'What Firms Do? Coordination, Identity, and Learning'. *Organizational Science*, Vol. 7 No. 5, pp.502–518.

de Koning, H. et al., (2006) 'Lean Six Sigma in Healthcare'. *Journal for Healthcare Quality*, Vol. 28 No. 2, pp.4–11.

Kozlowski, S.W.J. et al., (2013) 'Advancing Multilevel Research: Capturing the Dynamics of Emergence'. *Organizational Research Methods*, Vol. 16 No. 4, pp.581–615.

Kozlowski, S.W.J. & Ilgen, D.R., (2006) 'Enhancing the Effectiveness of Work Groups and Teams'. *Psychological Science in the Public Interest*, Vol. 7 No. 3, pp.77–124. Available at: http://psi.sagepub.com/lookup/doi/10.1111/j.1529-1006.2006.00030.x [Accessed June 12, 2016].

Kozlowski, S.W.J. & Klein, K.J., (2000) 'A Multilevel Approach to Theory and Research in Organizations: Contextual, Temporal and Emergent Processes'. In K. J. Klein & S. W. Kozlowski, eds. *Multilevel Theory, Research and Methods in Organizations: Foundations, Extensions, and New Directions*. San Francisco, USA: Jossey-Bass, pp. 3–90.

Lai, K.-H., Wong, C.W.Y. & Cheng, T.C.E., (2010) 'Bundling Digitized Logistics Activities and its Performance Implications'. *Industrial Marketing Management*, Vol. 39 No. 2, pp.273–286.

Laudan, L., (1981) *Science and Hypothesis*, Dordrecht, the Netherlands: Reidel.

LaValle, S. et al., (2010) 'Big Data, Analytics and the Path from Insights to Value'. *MIT Sloan Management Review*, Vol. 52 No. 2, pp.21–31.

Lee, A.S. & Baskerville, R.L., (2003) 'Generalizing Generalizability in Information Systems Research'. *Information Systems Research*, Vol. 14 No. 3, pp.221–243. Available at: http://pubsonline.informs.org/doi/abs/10.1287/isre.14.3.221.16560 [Accessed September 5, 2016].

Lee, J.-M., Gang, I.-S. & Yu, S.-J., (2015) 'The Influence of Nursing Informatics Competency on Job-Satisfaction and Nursing Performance'. *The Korean Journal of Health Service Management*, Vol. 9 No. 1, pp.109–122. Available at: http://www.koreascience.or.kr/article/ArticleFullRecord.jsp?cn=BGORA4_2015_v9n1_109 [Accessed May 17, 2016].

Lee, T.W., (1999) *Using Qualitative Methods in Organizational Research*, Thousand Oaks, CA, USA: Sage Publications.

Li, W.-D. et al., (2008) 'The Influence of Organizational Culture on Work-Related Personality Requirement Ratings: A Multilevel Analysis'. *International Journal of Selection and Assessment*, Vol. 16 No. 4, pp.366–384.

Liang, J. & Wu, S., (2010) 'Nurses' Motivations for Web-based Learning and the Role of Internet Self-efficacy'. *Innovations in Education and Teaching International*, Vol. 47 No. 1, pp.25–37.

Liao, H. & Chuang, A., (2004) 'A Multilevel Investigation of Factors Influencing Employee Service Performance and Customer Outcomes'. *Academy of Management Journal*, Vol. 47 No. 1, pp.41–58.

Limaj, E., Bernroider, E.W.N. & Choudrie, J., (2016) 'The Impact of Social Information System Governance, Utilization, and Capabilities on Absorptive Capacity and Innovation: A Case of Austrian SMEs'. *Information & Management*, Vol. 53, pp.380–397.

Lin, H.-C., Hsu, M.-H. & Yang, C.-W., (2014) 'The Influences of Computer System Success and Informatics Competencies on Organizational Impact in Nursing Environments.'. *Computers, Informatics, Nursing: CIN*, Vol. 32 No. 2, pp.90–99. Available at: http://www.ncbi.nlm.nih.gov/pubmed/24132084 [Accessed May 17, 2016].

Lin, L.-M. et al., (2012) 'Critical Managerial Activity and Competency of Healthcare

Management'. *International Journal of Asian Business and Information Management*, Vol. 3 No. 1, pp.11–20.

Liu, H. et al., (2013) 'The Impact of IT Capabilities on Firm Performance: The Mediating Roles of Absorptive Capacity and Supply Chain Agility'. *Decision Support Systems*, Vol. 54 No. 1452–1462, pp.1452–1462. Available at: http://www.sciencedirect.com/science/article/pii/S016792361200382X [Accessed April 5, 2015].

Loefsten, H., (2014) 'Product innovation processes and the trade-off between product innovation performance and business performance'. *European Journal of Innovation Management*, Vol. 17 No. 1, pp.61–84.

Luftman, J. & Brier, T., (1999) 'Achieving and Sustaining Business-IT Alignment'. *California Management Review*, Vol. 42 No. 1, pp.109–122. Available at: https://www.researchgate.net/publication/239062439_Achieving_and_Sustaining_Business-IT_Alignment [Accessed May 9, 2016].

Maas, C.J.M. & Hox, J.J., (2005) 'Sufficient Sample Sizes for Multilevel Modeling'. *Methodology*, Vol. 1 No. 3, pp.86–92.

Malhotra, A., Gosain, S. & El Sawy, O.A., (2005) 'Absorptive Capacity Configurations in Supply Chains: Gearing for Partner-Enabled Market Knowledge Creation'. *Management Information Systems Quarterly*, Vol. 29 No. 1, pp.145–187.

Mantas, J. et al., (2010) 'Recommendations of the International Medical Informatics Association (IMIA) on Education in Biomedical and Health Informatics. First Revision.'. *Methods of information in medicine*, Vol. 49 No. 2, pp.105–120.

Marrone, J.A., Tesluk, P.E. & Carson, J.B., (2007) 'A Multilevel Investigation of Antecedents and Consequences of Team Member Boundary-Spanning Behavior'. *Academy of Management Journal*, Vol. 50 No. 6, pp.1423–1439.

Martin-Misener, R. et al., (2009) 'Cost Effectiveness and Outcomes of a Nurse Practitioner–Paramedic–Family Physician Model of Care: The Long and Brier Islands Study'. *Primary Health Care Research & Development*, Vol. 10 No. 1, pp.14–25.

Martin, J., (2010) 'Dynamic Managerial Capabilities and the Multibusiness Team: The Role of Episodic Teams in Executive Leadership Groups'. *Organization Science*, Vol. 22 No. 1, pp.118–140.

Mason, J., (2006) *Six Strategies for Mixing Methods and Linking Data in Social Science Research*, Manchester, UK. Available at: http://eprints.ncrm.ac.uk/482/1/0406_six%252520strategies%252520for%252520mixing%252520methods.pdf.

Mason, S. et al., (2007) 'Effectiveness of Paramedic Practitioners in Attending 999 Calls from Elderly People in the Community: Cluster Randomised Controlled Trial'. *British Medical Journal (Clinical Research Ed.)*, Vol. 335 No. 919.

Mason, S., Wardrope, J. & Perrin, J., (2003) 'Developing a Community Paramedic Practitioner Intermediate Care Support Scheme for Older People with Minor Conditions.'. *Emergency Medicine Journal*, Vol. 20 No. 2, pp.196–198.

Maunder, K. et al., (2015) 'Uptake of Nutrition Informatics in Australia Compared with the USA'. *Nutrition & Dietetics*, Vol. 72 No. 3, pp.291–298. Available at: http://doi.wiley.com/10.1111/1747-0080.12207 [Accessed May 18, 2016].

Mazza, G., Battles, M. & Orthner, H.F., (2006) 'Application of Speech Recognition Data Entry Enhancements in an Electronic Patient Care Report (ePCR).'. *AMIA Annual Symposium Proceedings*, Vol. 2006, p.1026. Available at: http://www.ncbi.nlm.nih.gov/pubmed/17238645 [Accessed June 21, 2016].

McClelland, D.C., (1973) 'Testing for Competence Rather than for "Intelligence"'. *The American Psychologist*, Vol. 28 No. 1, pp.1–14.

McNeil, B.J. et al., (2005) 'Nursing Informatics Knowledge and Competencies: A National Survey of Nursing Education Programs in the United States.'. *International Journal of Medical Informatics*, Vol. 74 No. 11–12, pp.1021–1030. Available at: http://www.ncbi.nlm.nih.gov/pubmed/16046276 [Accessed February 8, 2014].

Menor, L.J. & Roth, A. V., (2007) 'New Service Development Competence in Retail Banking: Construct Development and Measurement Validation'. *Journal of Operations Management*, Vol. 25 No. 4, pp.825–846. Available at: http://www.sciencedirect.com/science/article/pii/S0272696306000970 [Accessed August 27, 2014].

Miles, M.B. & Huberman, A.M., (1994) *Qualitative Data Analysis: An Expanded Sourcebook* 2nd ed., Thousand Oaks, CA, USA: Sage Publications.

Mirabile, R.J., (1997) 'Everything you Wanted to Know about Competency Modeling'. *Training and Development*, No. August, pp.73–77.

Mitchell, T.A., (1994) 'Nonurgent Emergency Department Visits--Whose Definition?'. *Annals of Emergency Medicine*, Vol. 24 No. 5, pp.961–963.

Moskop, J.C. et al., (2009) *Emergency Department Crowding, Part 1—Concept, Causes, and Moral Consequences*,

Moulton, D., (2011) 'Paramedic Program Reducing Emergency Room Congestion'. *Canadian Medical Association Journal*, Vol. 183 No. 10, pp.E631–E632. Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3134746&tool=pmcentrez&rendertype=abstract [Accessed March 1, 2014].

Narasimhan, R. & Kim, S.W., (2002) 'Effect of Supply Chain Integration on the Relationship between Diversification and Performance: Evidence from Japanese and Korean firms'. *Journal of Operations Management*, Vol. 20 No. 3, pp.303–323.

National Highway Traffic Safety Administration (NHTSA), (2013) 'Innovation Opportunities for Emergency Medical Services: A Draft White Paper from the Administration'. Available at: http://www.ems.gov/pdf/2013/EMS_Innovation_White_Paper-draft.pdf [Accessed May 30, 2016].

National Registry of Emergency Medical Technicians (NREMT), (2000) 'Education Agenda for the Future: A Systems Approach'. Available at: http://www.nhtsa.gov/people/injury/ems/FinalEducationAgenda.pdf [Accessed May 17, 2016].

Nelson, J. et al., (2008) 'The School-Wide Cultural Competence Observation Checklist for School Counselors: An Exploratory Factor Analysis'. *Professional School Counseling*, Vol. 11 No. 4, pp.207–217. Available at: http://professionalschoolcounseling.org/doi/10.5330/PSC.n.2010-11.207 [Accessed June 12, 2016].

Newgard, C.D., (2011) 'Developing a Statewide Emergency Medical Services Database Linked

to Hospital Outcomes: A Feasibility Study'. *Prehospital Emergency Care*, Vol. 15 No. 3, pp.303–319. Available at: http://resolver.scholarsportal.info/resolve/10903127/v15i0003/303_dasemsthoafs.xml [Accessed June 21, 2016].

NHS North West Ambulance Service, (2015) 'New Community Specialist Paramedics'. Available at: http://www.nwas.nhs.uk/news/stakeholder-briefing/summer-2015/new-community-specialist-paramedics/ [Accessed June 4, 2016].

Nieves, J. & Haller, S., (2014) 'Building Dynamic Capabilities through Knowledge Resources'. *Tourism Management*, Vol. 40, pp.224–232.

Nonaka, I. & Takeuchi, H., (1995) *The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation*, New York City, USA: Oxford University Press.

Nonaka, I. & Toyama, R., (2007) 'Strategic Management as Distributed Practical Wisdom (Phronesis)'. *Industrial and Corporate Change*, Vol. 16 No. 3, pp.371–394.

Norman, C., Mello, M. & Choi, B., (2016) 'Identifying Frequent Users of an Urban Emergency Medical Service Using Descriptive Statistics and Regression Analyses.'. *The western journal of emergency medicine*, Vol. 17 No. 1, pp.39–45. Available at: http://www.ncbi.nlm.nih.gov/pubmed/26823929 [Accessed June 23, 2016].

Novascotia.ca, (2012) 'Extended Care Paramedic Program Earns National Award'. *http://novascotia.ca*. Available at: http://novascotia.ca/news/release/?id=20120215001 [Accessed May 3, 2016].

Nunnally, J.C., (1978) *Psychometric Theory* 2nd Ed., New York, New York, USA: McGraw-Hill.

Nyberg, A.J. et al., (2014) 'Resource-Based Perspectives on Unit-Level Human Capital: A Review and Integration'. *Journal of Management*, Vol. 40 No. 1, pp.316–346. Available at: http://jom.sagepub.com/cgi/doi/10.1177/0149206312458703 [Accessed September 4, 2016].

O'Brien, W., (2012) 'FASTER (Face, Arm, Speech, Time, Emergency Response): Experience of Central Coast Stroke Services Implementation of a Pre-Hospital Notification System for Expedient Management of Acute Stroke'. *Journal of Clinical Neuroscience*, Vol. 19 No. 2, pp.241–245. Available at: http://resolver.scholarsportal.info/resolve/09675868/v19i0002/241_fasterfemoas.xml [Accessed June 21, 2016].

O'Carroll, P., (2002) 'Informatics Competencies for Public Health Professionals'. , No. August. Available at: http://www.nwcphp.org/phi/comps [Accessed May 14, 2016].

O'Meara, P. et al., (2007) 'The Rural and Regional Ambulance Paramedic: Moving beyond Emergency Response'. In *9th National Rural Health Conference*. Darwin, NT, Australia.

O'Meara, P.F., Ruest, M. & Stirling, C., (2014) 'Community Paramedicine: Higher Education as an Enabling Factor'. *Australasian Journal of Paramedicine*, Vol. 11 No. 2.

OECD, (2013) *ICTs and the Health Sector: Towards Smarter Health and Wellness Models*, Paris, France: OECD Publishing.

Okhuysen, G.A. & Eisenhardt, K.M., (2002) 'Integrating Knowledge into Groups: How Formal Interventions Enable Flexibility'. *Organizational Science*, Vol. 13 No. 4, pp.370–386.

Olynyk, C., Thurston, A. & Klitch, J., (2010) 'Community Referrals by EMS: An Extension of

Service'. Available at: http://ircp.info/Portals/11/Downloads/Expanded Role/Toronto CREMS/CREMS/CREMS Presentation November 2010.pdf [Accessed May 2, 2016].
Ontario Ministry of Health and Long-Term Care (MOHLTC), (2012) 'Emergency Health Services Branch'. Available at: http://www.health.gov.on.ca/english/public/program/ehs/ehs_dt.html.
Ontario Ministry of Health and Long-Term Care (MOHLTC), (2014) 'Ontario Expanding Community Role for Paramedics'. Available at: http://news.ontario.ca/mohltc/en/2014/01/ontario-expanding-community-role-for-paramedics.html [Accessed March 1, 2014].
Ontario Ministry of Health and Long-Term Care (MOHLTC), (2007) *Preventing and Managing Chronic Disease: Ontario's Framework*,
Ordanini, A. & Rubera, G., (2010) 'How Does the Application of an IT Service Innovation Affect Firm Performance? A Theoretical Framework and Empirical Analysis on e-Commerce'. *Information & Management*, Vol. 47 No. 1, pp.60–67. Available at: http://www.sciencedirect.com/science/article/pii/S0378720609001293 [Accessed March 13, 2016].
Ottenbacher, M.C. & Harrington, R.J., (2010) 'Strategies for Achieving Success for Innovative Versus Incremental New Services'. *Journal of Services Marketing*, Vol. 24 No. 1, pp.3–15.
Ozbolt, J.G. & Graves, J.R., (1993) 'Clinical Nursing Informatics: Developing Tools for Knowledge Workers'. *The Nursing Clinics of North America*, Vol. 28 No. 2, pp.407–425.
Pablo, A.L. et al., (2007) 'Identifying, Enabling and Managing Dynamic Capabilities in the Public Sector'. *Journal of Management Studies*, Vol. 44 No. 5, pp.687–708.
Page, T., (2014) 'Notions of Innovation in Healthcare Services and Products'. *International Journal of Innovation and Sustainable Development*, Vol. 8 No. 3, pp.217–231.
Paramedic Association of Canada (PAC), (2011) 'National Occupational Competency Profile for Paramedics'. Available at: http://www.paramedic.ca/uploaded/web/documents/2011-10-31-Approved-NOCP-English-Master.pdf [Accessed October 12, 2016].
Paterson, W.G. et al., (2006) 'Canadian consensus on medically acceptable wait times for digestive health care'. *Canadian Journal of Gastroenterology*, Vol. 20 No. 6, pp.411–423.
Patton, M.Q., (1990) *Qualitative Evaluation and Research Methods*, Newbury Park, CA, USA: Sage Publications.
Pavlou, P.A. & Fygenson, M., (2006) 'Understanding and Predicting Electronic Commerce Adoption: An Extension of the Theory of Planned Behavior'. *Management Information Systems Quarterly*, Vol. 30 No. 1, pp.115–143.
Pavlou, P.A. & El Sawy, O.A., (2011) 'Understanding the Elusive Black Box of Dynamic Capabilities'. *Decision Sciences*, Vol. 42 No. 1, pp.239–273.
Pearce, J.A. & Robinson, R., (2004) *Strategic Management: Formulation, Implementation, and Control* 9th ed., Chicago, IL, USA: McGraw-Hill.
Pedhazur, E.J., (1991) 'Reliability'. In E. J. Pedhazur & L. P. Schmelkin, eds. *Measurement, Design and Analysis: An Integrated Approach*. New York City, USA: Taylor & Francis.
Petter, S., DeLone, W. & McLean, E., (2008) 'Measuring Information Systems Success: Models, Dimensions, Measures, and Interrelationships'. *European Journal of Information Systems*, Vol. 17 No. 3, pp.236–263.
Pew, (1998) *Recreating Health Professional Practice for a New Century*, San Francisco, USA.

Phillips, D.C. & Barbules, N.C., (2000) *Postpositivism and Educational Research*, Lanham, MD: Rowman & Littlefield.

Picard, A., (2014) *Why Community Paramedicine Saves Both Money and Lives*, Available at: http://www.theglobeandmail.com/life/health-and-fitness/health/why-community-paramedicine-saves-both-money-and-lives/article16905592/ [Accessed March 1, 2014].

Piccoli, G. & Ives, B., (2005) 'Review: IT-Dependent Strategic Initiatives and Sustained Competitive Advantage: A Review and Synthesis of the Literature'. *Management Information Systems Quarterly*, Vol. 29 No. 4, pp.747–766.

Ployhart, R.E. & Moliterno, T.S., (2011) 'Emergence of the Human Capital Resource: A Multilevel Model'. *Academy of Management Review*, Vol. 36 No. 1, pp.127–150.

Ployhart, R.E., Weekley, J.A. & Baughman, K., (2006) 'The Structure and Function of Human Capital Emergence: A Multilevel Examination of the Attraction-Selection-Attrition Model'. *Academy of Management Journal*, Vol. 49 No. 4, pp.661–677.

Podsakoff, P.M. et al., (2003) 'Common Method Biases in Behavioral Research: A Critical Review of the Literature and Recommended Remedies'. *Journal of Applied Psychology*, Vol. 88 No. 5, pp.879–903. Available at: http://www.ncbi.nlm.nih.gov/pubmed/14516251.

Popper, M. & Lipshitz, R., (1998) 'Organizational Learning Mechanisms: A Structural and Cultural Approach to Organizational Learning'. *The Journal of Applied Behavioral Science*, Vol. 34 No. 2, pp.161–179. Available at: http://jab.sagepub.com/content/34/2/161 [Accessed May 18, 2016].

Powell, T.C. & Dent-Micallef, A., (1997) 'Information Technology as Competitive Advantage: The Role of Human, Business and Technology Resources'. *Strategic Management Journal*, Vol. 18 No. 5, pp.375–405.

Ragatz, G.L., Handfield, R.B. & Petersen, K.J., (2002) 'Benefits Associated with Supplier Integration into new Product Development Under Conditions of Technology Uncertainty'. *Journal of Business Research*, Vol. 55 No. 5, pp.389–400. Available at: http://www.sciencedirect.com/science/article/pii/S0148296300001582 [Accessed September 9, 2014].

Rai, A., Patnayakuni, R. & Seth, N., (2006) 'Firm Performance Impacts of Digitally Enabled Supply Chain Integration Capabilities'. *Management Information Systems Quarterly*, Vol. 30 No. 2, pp.225–246.

Rai, A. & Tang, X., (2010) 'Leveraging IT Capabilities and Competitive Process Capabilities for the Management of Interorganizational Relationship Portfolios'. *Information Systems Research*, Vol. 21 No. 3, pp.516–542. Available at: http://pubsonline.informs.org/doi/abs/10.1287/isre.1100.0299 [Accessed May 18, 2016].

Raudenbush, S.W. & Bryk, A.S., (2002) *Hierarchical Linear Models: Applications and Data Analysis Methods* 2nd ed., Thousand Oaks, CA, USA: Sage Publications.

Raymond, L., Paré, G. & Maillet, É., (2015) 'IT-Enabled Knowledge Management in Primary Care: An Absorptive Capacity Perspective'. In *Proc. of ICIS*. Fort Worth, TX, USA.

van Reijsen, J. et al., (2015) 'The Impact of Knowledge Management and Social Capital on Dynamic Capability in Organizations'. *Knowledge Management Research & Practice*, Vol. 13 No. 4, pp.401–417.

Reise, S.P. & Duan, N., (1999) 'Multilevel Modeling and its Application in Counseling Psychology Research'. *The Counselling Psychologist*, Vol. 27 No. 4, pp.528–551.

Richardson, D.B., (2006) 'Increase in Patient Mortality at 10 Days Associated with Emergency Department Overcrowding'. *The Medical Journal of Australia*, Vol. 184 No. 5, pp.213–216.

Ridder, H.-G., Doege, V. & Martini, S., (2007) 'Differences in the Implementation of Diagnosis-Related Groups across Clinical Departments: A German Hospital Case Study'. *Health Services Research*, Vol. 42 No. 6, pp.2120–2139. Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2151394&tool=pmcentrez&rendertype=abstract [Accessed June 11, 2014].

Ringle, C.M., Sarstedt, M. & Straub, D.W., (2012) 'Editor's Comments: A Critical Look at the Use of PLS-SEM in MIS Quarterly'. *Management Information Systems Quarterly*, Vol. 36 No. 1, pp.iii–xiv.

Rogers, E.M., (2003) *Diffusion of Innovations*, Free Press.

Ross, J.W., Beath, C.M. & Goodhue, D., (1996) 'Develop Long-Term Competitiveness through IT Assets'. *Sloan Management Review*, Vol. 38 No. 1, pp.31–45.

Sambamurthy, V. & Zmud, R.W., (1997) 'At the Heart of Success: Organization wide Management Competence'. In C. Sauer & P. Yetton, eds. *Steps to the Future: Fresh Thinking on the Management of IT-Based Organizational Transformation*. San Francisco, USA: Jossey-Bass, pp. 143–163.

Sanders, N.R., (2005) 'IT Alignment in Supply Chain Relationships: A Study of Supplier Benefits'. *The Journal of Supply Chain Management*, Vol. 41 No. 2, pp.4–13.

Schooley, B. et al., (2010) 'Improving IT Enabled Continuity of Care Across Pre- Hospital and Hospital Settings'. In *AMCIS 2010 Proceedings*. Available at: http://aisel.aisnet.org/amcis2010/584 [Accessed June 20, 2016].

Seddon, P. & Scheepers, R., (2006) 'Other-Settings Generalizability in IS Research'. *ICIS 2006 Proceedings*. Available at: http://aisel.aisnet.org/icis2006/70 [Accessed September 5, 2016].

Shrout, P.E. & Fleiss, J.L., (1979) 'Intraclass Correlations: Uses in Assessing Rater Reliability'. *Psychological Bulletin*, Vol. 86 No. 2, pp.420–428.

Singh, H. et al., (2010) 'Notification of Abnormal Lab Test Results in an Electronic Medical Record: Do any Safety Concerns Remain?'. *The American Journal of Medicine*, Vol. 123 No. 3, pp.238–244. Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2878665&tool=pmcentrez&rendertype=abstract [Accessed April 9, 2013].

Singh, R. et al., (2011) 'Dynamic Capabilities in Home Health: IT-Enabled Transformation of Post-Acute Care'. *Journal of the Association for Information Systems*, Vol. 12 No. 2, pp.163–188.

Sittig, D.F. & Singh, H., (2010) 'A New Sociotechnical Model for Studying Health Information Technology in Complex Adaptive Healthcare Systems'. *Quality & Safety in Health Care*, Vol. 19 Suppl 3, pp.i68–i74.

Snijders, T.A.B. & Bosker, R.J., (1999) *Multilevel Analysis: An Introduction to Basic and Advanced Multilevel Modeling*, Thousand Oaks, CA, USA: Sage Publications.

Sofianopoulos, S., Williams, B. & Archer, F., (2012) 'Paramedics and the Effects of Shift Work on Sleep: A Literature Review'. *Emergency Medicine Journal*, Vol. 29 No. 2, pp.152–155. Available at: http://www.ncbi.nlm.nih.gov/pubmed/20956391 [Accessed February 22, 2014].

Spender, J.-C., (1996) 'Making Knowledge the Basis of a Dynamic Theory of the Firm'. *Strategic*

Management Journal, Vol. 17 No. S2, pp.45–62. Available at: http://doi.wiley.com/10.1002/smj.4250171106 [Accessed June 11, 2016].

Sprivulis, P.C. et al., (2006) 'The Association Between Hospital Overcrowding and Mortality among Patients Admitted via Western Australian Emergency Departments'. *Medical Journal of Australia*, Vol. 184 No. 5, pp.208–212. Available at: http://www.ncbi.nlm.nih.gov/pubmed/16515429 [Accessed June 23, 2016].

Srinivasan, M. et al., (2011) '"Teaching as a Competency": Competencies for Medical Educators'. *Academic Medicine*, Vol. 86 No. 10, pp.1211–1220.

Staggers, N., Gassert, C.A. & Curran, C.R., (2002) 'A Delphi Study to Determine Informatics Competencies for Nurses at Four Levels of Practice.'. *Nursing Research*, Vol. 51 No. 6, pp.383–390.

Staggers, N., Gassert, C.A. & Curran, C.R., (2001) 'Informatics Competencies for Nurses at Four Levels of Practice'. *The Journal of Nursing Education*, Vol. 40 No. 7, pp.303–316.

StatsCan, (2010) *Estimates of Population, by Age Group and Sex for July 1, Canada, Provinces and Territories, Annual (CANSIM Table 051-0001).*, Ottawa, Ontario, Canada.

Stone, M., (1974) 'Cross-Validatory Choice and Assessment of Statistical Predictions'. *Journal of the Royal Statistical Society*, Vol. 36 No. 2, pp.111–147.

Stowens, J.C., Sonnad, S.S. & Rosenbaum, R.A., (2015) 'Using EMS Dispatch to Trigger STEMI Alerts Decreases Door-to-Balloon Times.'. *The Western Journal of Emergency Medicine*, Vol. 16 No. 3, pp.472–480. Available at: http://www.ncbi.nlm.nih.gov/pubmed/25987932 [Accessed June 21, 2016].

Strauss, D.G. et al., (2007) 'Paramedic Transtelephonic Communication to Cardiologist of Clinical and Electrocardiographic Assessment for Rapid Reperfusion of ST-Elevation Myocardial Infarction'. *Journal of Electrocardiology*, Vol. 40 No. 3, pp.265–270. Available at: http://www.ncbi.nlm.nih.gov/pubmed/17292381 [Accessed June 20, 2016].

Suddaby, R., (2006) 'From the Editors: What Grounded Theory Is Not'. *Academy of Management Journal*, Vol. 49 No. 4, pp.633–642. Available at: http://amj.aom.org/cgi/doi/10.5465/AMJ.2006.22083020 [Accessed June 17, 2016].

Tallon, P.P., Kraemer, K.L. & Gurbaxani, V., (2000) 'Executives' Perceptions of the Business Value of Information Technology: A Process-Oriented Approach'. *Journal of Management Information Systems*, Vol. 16 No. 4, pp.145–173.

Tan, J., Wen, H.J. & Awad, N., (2005) 'Health Care and Services Delivery Systems as Complex Adaptive Systems: Examining Chaos Theory in Action'. *Communications of the Association for Computing Machinery*, Vol. 48 No. 5, pp.36–44.

Tanriverdi, H., (2005) 'Information Technology Relatedness Knowledge Management Capability, and Performance of Multibusiness Firms'. *Management Information Systems Quarterly*, Vol. 29 No. 2, pp.311–334.

Tarafdar, M. & Gordon, S.R., (2007) 'Understanding the Influence of Information Systems Competencies on Process Innovation: A Resource-Based View'. *Journal of Strategic Information Systems*, Vol. 16 No. 4, pp.353–392. Available at: http://www.sciencedirect.com/science/article/pii/S0963868707000467 [Accessed February 26, 2014].

Tashakkori, A. & Teddlie, C., (2010) *Handbook of Mixed Methods in Social and Behavioral Research* 2nd ed., Thousand Oaks, CA, USA: SAGE Publications.

Teece, D.J., (2007) 'Explicating Dynamic Capabilities: The Nature and Microfoundations of (Sustainabile) Enterprise Performance'. *Strategic Management Journal*, Vol. 298, pp.1319–1350.

Teece, D.J., Pisano, G. & Shuen, A., (1997) 'Dynamic Capabilities and Strategic Management'. *Strategic Management Journal*, Vol. 18 No. 7, pp.509–533.

Tenenhaus, M. et al., (2005) 'PLS Path Modeling'. *Computational Statistics & Data Analysis*, Vol. 48 No. 1, pp.159–205.

Tesch, D. et al., (2009) 'User and developer common knowledge: Effect on the success of information system development projects'. *International Journal of Project Management*, Vol. 27, pp.657–664.

The TIGER Initiative, (2006) *Informatics Competencies for Every Practicing Nurse: Recommendations from the TIGER Collaborative*, Available at: http://www.tigersummit.com [Accessed November 20, 2014].

Tian, J. et al., (2009) 'From IT Deployment Capabilities to Competitive Advantage: An Exploratory Study in China'. *Information Systems Frontiers*, Vol. 12 No. 3, pp.239–255. Available at: http://link.springer.com/10.1007/s10796-009-9182-z [Accessed May 18, 2016].

Timmons, S., (2003) 'Nurses Resisting Information Technology'. *Nursing Inquiry*, Vol. 10 No. 4, pp.257–269. Available at: http://doi.wiley.com/10.1046/j.1440-1800.2003.00177.x [Accessed June 24, 2016].

Tomer, J.F., (1987) *Organizational Capital: The Path to Higher Productivity and Well-Being.*, New York City, USA: Praeger.

Toronto, (2010) 'Toronto EMS Community Paramedicine Overview'. Available at: http://ircp.info/Portals/11/Downloads/Expanded Role/Toronto CREMS/Toronto EMS Community Paramedicine Program Overview 2010.pdf [Accessed May 4, 2016].

TravisCountyHD.org, 'Project Name: Community Health Paramedic Navigation Program'. Available at: http://texasregion7rhp.net/wp-content/uploads/2012/09/CCC-Community-Paramedic-Patient-Navigation-Program-Cat-2.pdf [Accessed May 26, 2016].

Tsai, W., (2001) 'Knowledge Transfer in Intraorganizational Networks: Effects of Network Position and Absorptive Capacity on Business Unit Innovation and Performance'. *Academy of Management Journal*, Vol. 44 No. 5, pp.996–1004.

Tukey, J.W., (1977) *Exploratory Data Analysis*, Reading, MA, USA: Addison-Wesley.

Tzokas, N. et al., (2015) 'Absorptive Capacity and Performance: The Role of Customer Relationship and Technological Capabilities in High-Tech SMEs'. *Industrial Marketing Management*, Vol. 47, pp.134–142.

Vanpoucke, E., Vereecke, A. & Wetzels, M., (2014) 'Developing Supplier Integration Capabilities for Sustainable Competitive Advantage: A Dynamic Capabilities Approach'. *Journal of Operations Management*, Vol. 32 No. 7, pp.446–461.

Venkatesh, V. et al., (2003) 'User Acceptance of Information Technology: Toward a Unified View'. *Management Information Systems Quarterly*, Vol. 27 No. 3, pp.425–478.

Venkatesh, V., Brown, S. & Bala, H., (2013) 'Bridging the Qualitative–Quantitative Divide: Guidelines for Conducting Mixed Methods Research in Information Systems'. *Management Information Systems Quarterly*, Vol. 37 No. 1, pp.21–54. Available at: http://aisel.aisnet.org/misq/vol37/iss1/3 [Accessed August 7, 2016].

Venkatesh, V. & Davis, F.D., (2000) 'A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies'. *Management Science*, Vol. 46 No. 2, pp.186–204.

Venkatraman, N. & Ramanujam, V., (1987) 'Measurement of Business Economic Performance: An Examination of Method Convergence'. *Journal of Management*, Vol. 13 No. 1, pp.109–122.

Walker, J.M. & Carayon, P., (2009) 'From Tasks to Processes: The Case for Changing Health Information Technology to Improve Health Care'. *Health Affairs*, Vol. 28 No. 2, pp.467–477. Available at: http://www.ncbi.nlm.nih.gov/pubmed/19276006 [Accessed June 15, 2016].

Wang, Y., Kung, L. & Byrd, T., (2013) 'Leveraging Event-driven IT Architecture Capability for Competitive Advantage in Healthcare Industry: A Mediated Model'. In *Proceedings of ICIS 2013*. Milan, Italy.

Weiss, S.J. et al., (2005) 'Automatic Transport Ventilator Versus Bag Valve in the EMS Setting: A Prospective, Randomized Trial'. *Southern Medical Journal*, Vol. 98 No. 10, pp.970–977.

Welch, G.F. et al., (2009) '3D Medical Collaboration Technology to Enhance Emergency Healthcare'. *Journal of Biomedical Discovery and Collaboration*, Vol. 4 No. 0, p.4.

Wernerfelt, B., (1984) 'A Resource-Based View of the Firm'. *Strategic Management Journal*, Vol. 5 No. 2, pp.171–180.

West, J. & Bogers, M., (2014) 'Leveraging External Sources of Innovation: A Review of Research on Open Innovation'. *Journal of Product Innovation Management*, Vol. 31 No. 4, pp.814–831.

Westra, B.L., Delaney, C.W. & Delaney, C., (2008) 'Informatics Competencies for Nursing and Healthcare Leaders'. In *AMIA Annual Symposium Proceedings*. Washington, DC, pp. 804–808.

Wetzels, M., Odekerken-Schroder, G. & Oppen, C. van, (2009) 'Using PLS Path Modeling for Assessing Hierarchical Construct Models: Guidelines and Empirical Illustration'. *Management Information Systems Quarterly*, Vol. 33 No. 1, pp.177–195.

White, R.W., (1959) 'Motivation Reconsidered: The Concept of Competence'. *Psychological Review*, Vol. 66 No. 5, pp.297–333.

Whittaker, M. et al., (2015) 'Preparing for the Data Revolution: Identifying Minimum Health Information Competencies among the Health Workforce'. *Human Resources for Health*, Vol. 13 No. 17.

WHO Collaborating Centre for Patient Safety Solutions, (2007) 'Communication During Patient Hand-overs. Patient Safety Solutions'. Available at: http://www.who.int/patientsafety/solutions/patientsafety/PS-Solution3.pdf [Accessed May 31, 2016].

Williamson, O., (1975) *Markets and Heirarchies*, New York City, USA: Free Press.

Winter, S., (2003) 'Understanding Dynamic Capabilities'. *Strategic Management Journal*, Vol. 24 No. 10, pp.991–995.

Winter, S.G. & Nelson, R.R., (1982) *An Evolutionary Theory of Economic Change*, Cambridge, MA, USA: Belknap Press.

Wixom, B.H. & Todd, P., (2005) 'A Theoretical Integration of User Satisfaction and Technology Acceptance'. *Information Systems Research*, Vol. 16 No. 1, pp.85–102.

Wold, H., (1966) 'Estimation of Principal Components and Related Models by Iterative Least

Squares'. In P. R. Krishnaiah, ed. *Multivariate Analysis*. New York: Academic Press, pp. 391–420.

Wold, H., (1980) 'Model Construction and Evaluation when Theoretical Knowledge is Scarce'. In J. Kmenta & J. B. Ramsey, eds. *Evaluation of Econometric Models*. New York City, USA: Academic Press, pp. 47–74.

Wong, C.Y., Boon-itt, S. & Wong, C.W.Y., (2011) 'The Contingency Effects of Environmental Uncertainty on the Relationship Between Supply Chain Integration and Operational Performance'. *Journal of Operations Management*, Vol. 29 No. 6, pp.604–615.

Woollard, M., (2006) 'The Role of the Paramedic Practitioner in the UK'. *Journal of Emergency Primary Health Care*, Vol. 4 No. 1.

Wu, Y. et al., (2015) 'The Impact of Knowledge from Learning-About Electronic Health Records on IT Innovation Adoption: The Moderating Role of Absorptive Capacity'. In *Proc. of SAIS 2015*. Hilton Head Island, SC, USA.

Xue, Y., Liang, H. & Boulton, W.R., (2008) 'Information Technology Governance in Information Technology Investment Decision Processes: The Impact of Investment Characteristics, External Environment, and Internal Context'. *Management Information Systems Quarterly*, Vol. 32 No. 1, pp.67–96.

Yasnoff, W. et al., (2000) 'Public Health Informatics: Improving and Transforming Public Health in the Information Age'. *Journal of Public Health Management and Practice*, Vol. 6 No. 6, pp.67–75.

Yeung, J. et al., (2009) 'The Use of CPR Feedback/Prompt Devices During Training and CPR Performance: A Systematic Review'. *Resuscitation*, Vol. 80 No. 7, pp.743–751.

Yoon, S., Yen, P.-Y. & Bakken, S., (2009) 'Psychometric Properties of the Self-Assessment of Nursing Informatics Competencies Scale'. *Studies in Health Technology and Informatics*, Vol. 146, pp.546–550.

Yourex-West, H., (2015) 'Anonymous Paramedics Tweet when No Ambulances are Available in Alberta'. *GlobalNews.ca*. Available at: http://globalnews.ca/news/1821039/anonymous-paramedics-tweet-when-no-ambulances-are-available-in-alberta/.

Yu, X. et al., (2015) 'Developing an Evidence-Based Public Health Informatics Course'. *Journal of the Medical Library Association*, Vol. 103 No. 4, pp.194–197. Available at: http://www.ncbi.nlm.nih.gov/pubmed/26512219 [Accessed April 6, 2016].

Yuan, Y.C. et al., (2010) 'Expertise Directory Development, Shared Task Interdependence, and Strength of Communication Network Ties as Multilevel Predictors of Expertise Exchange in Transactive Memory Work Groups'. *Communication Research*, Vol. 37 No. 1, pp.20–47.

Zahra, S.A. & George, G., (2002) 'Absorptive Capacity: A Review, Reconceptualization, and Extension'. *Academy of Management Review*, Vol. 27 No. 2, pp.185–203.

Zahra, S.A. & Nielsen, A.P., (2002) 'Sources of Capabilities, Integration and Technology Commercialization.'. *Strategic Management Journal*, Vol. 23, pp.377–398.

Zahra, S.A., Sapienza, H.J. & Davidsson, P., (2006) 'Entrepreneurship and Dynamic Capabilities: A Review, Model and Research Agenda'. *Journal of Management Studies*, Vol. 43 No. 4, pp.917–955.

Zmud, R., (1982) 'Diffusion of Modern Software Practices: Influence of Centralization and Formalization'. *Management Science*, Vol. 28 No. 12, pp.1421–1431.

Zollo, M. & Winter, S., (2002) 'Deliberate Learning and the Evolution of Dynamic Capabilities'.

Organization Science, Vol. 13 No. 3, pp.339–351.
Zytkowski, M.E., (2003) 'Nursing Informatics: The Key to Unlocking Contemporary Nursing Practice'. *AACN Advanced Critical Care*, Vol. 14 No. 3, pp.271–281.

Appendix A – Paramedic Instrument and Recruitment Material

Recruitment Email Template. This script is to be sent from each Paramedic Leader to the paramedics within their organization, therefore it is expected that some appropriate customization must be allowed. This document contains 4 emails: one initial, and 3 follow ups.

Initial Email

E-mail Subject line: PARTICIPANTS WANTED – Research for Information Technology in Paramedicine

Dear Employees,

Michael S. Dohan, a student at McMaster University in Hamilton, Ontario, has contacted [our organization name] asking us to tell our paramedics about a study he is doing on the use of information technology in paramedicine. This research is part of his Doctoral Degree in Business Administration at McMaster University, Hamilton, Ontario.

As part of the study, you will be asked to complete an anonymous online questionnaire, which should take about 15-20 minutes to complete, at a time that is convenient for you. The questions involve self-assessments of your knowledge and skills with using technology in a healthcare environment.

You will have a chance to be entered into a draw for a prize worth $500 (1 in 500 chances to win).

If you are interested in participating or learning more about the study please visit: http://emsstudy.com/paramedic

This study has been reviewed and cleared by the McMaster Research Ethics Board. If you have questions or concerns about your rights as a participant or about the way the study is being conducted you may contact:

McMaster Research Ethics Board Secretariat

Telephone: (905) 525-9140 ext. 23142

Gilmour Hall – Room 305 (ROADS)

E-mail: ethicsoffice@mcmaster.ca

You can also CONTACT MICHAEL DIRECTLY by phone or email address. Tel: 807-630-4426 or dohanms@mcmaster.ca.

Sincerely,

Paramedic Leader

Title

Organization

First/Second Follow Up Email

E-mail Subject line: REMINDER: Participants Wanted – Research for Information Technology in Paramedicine

Dear Employees,

I have contacted you previously about Michael S. Dohan, a student at McMaster University in Hamilton, Ontario, regarding research he is doing on the use of information technology in paramedicine. This research is part of his Doctoral Degree in Business Administration at McMaster University, Hamilton, Ontario.

As part of the study, you will be asked to complete an anonymous online questionnaire, which should take about 15-20 minutes to complete, at a time that is convenient for you. The questions involve self-assessments of your knowledge and skills with using technology in a healthcare environment.

You will have a chance to be entered into a draw for a prize worth $500 (1 in 500 chances to win).

If you are interested in participating or learning more about the study please visit: http://emsstudy.com/paramedic

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You can also CONTACT MICHAEL DIRECTLY by phone or email address. Tel: 807-630-4426 or dohanms@mcmaster.ca.

Sincerely,

Paramedic Leader

Title

Organization

Final Follow Up Email

E-mail Subject line: FINAL REMINDER: Participants Wanted – Research for Information Technology in Paramedicine

Dear Employees,

I have contacted you previously about Michael S. Dohan, a student at McMaster University in Hamilton, Ontario, regarding research he is doing on the use of information technology in paramedicine. This research is part of his Doctoral Degree in Business Administration at McMaster University, Hamilton, Ontario.

As part of the study, you will be asked to complete an anonymous online questionnaire, which should take about 15-20 minutes to complete, at a time that is convenient for you. The questions involve self-assessments of your knowledge and skills with using technology in a healthcare environment.

You will have a chance to be entered into a draw for a prize worth $500 (1 in 500 chances to win).

If you are interested in participating or learning more about the study please visit: http://emsstudy.com/paramedic

This study has been reviewed and cleared by the McMaster Research Ethics Board. If you have questions or concerns about your rights as a participant or about the way the study is being conducted you may contact:

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E-mail: ethicsoffice@mcmaster.ca

You can also CONTACT MICHAEL DIRECTLY by phone or email address. Tel: 807-630-4426 or dohanms@mcmaster.ca.

Sincerely,

Paramedic Leader

Title

Organization

Letter of Information (also available in online form)

Investigating Service Innovation for Community Paramedicine: The roles of Dynamic Capabilities, IT Capabilities, and Healthcare Informatics Competencies

Principal Investigator:
Dr. Joseph Tan
DeGroote School of Business
McMaster University
Hamilton, Ontario, Canada
(905) 525-9140 ext. 26166
E-mail: tanjosep@mcmaster.ca

Student Investigator:
Mr. Michael Dohan
DeGroote School of Business
McMaster University
Hamilton, Ontario, Canada
(807) 630 4426
E-mail: dohanms@mcmaster.ca

Purpose of the Study

The purpose of the survey is to investigate how the ability of a Land Ambulance Service (LAS) to exploit technology impacts the ability of an LAS to develop innovative service delivery models. This research is being conducted as part of Mr. Dohan's doctoral dissertation for his PhD in Business Administration.

We invite paramedics employed by Canadian Land Ambulance Services to take part in this study.

Procedures involved in the Research

This study will involve the completion of a survey that will take approximately 20 minutes to fill out. This questionnaire can be completed at a time that is convenient for you. The survey questions are for the self-evaluation of your knowledge and skills related to using technology in a healthcare environment.

For example, you will be asked to evaluate yourself using the following questions:

- Collect, summarize, and interpret information relevant to an issue
- Find online data and information from multiple sources
- Assess the validity and authoritativeness of data and information retrieved from online sources

You will also be asked the relevance of each of these skills to your job, and some demographic information concerning your job qualifications and activities.

Are there any risks to doing this study?

It is not likely that there will be any harms or discomforts associated with participating in this study.

You do not need to answer questions that you do not want to answer or that make you feel uncomfortable.

I describe below the steps I am taking to protect your privacy.

Are there any benefits to doing this study?

The research itself will not benefit you directly. We hope to learn more about how paramedics can contribute to organizational activities related to developing and implementing innovative service delivery models. This could help determine an important driver of performance improvement and improving the well-being of the citizens you serve.

Payment or Reimbursement

You can choose to be entered into a draw for a prize worth $500.

Who will know what I said or did in the study?

This survey is anonymous, therefore nobody will know how you answered in the study, or whether you have taken part, including myself.

Although your Paramedic Leader will be answering another survey as part of this study, they will not have access to your answers. Also, they will not be evaluating you.

Your answers will be kept on a secure server where only the researchers will have access to this data.

When the final report is created from this data, you will not be identified.

You will have to submit your email if you wish to be entered in to the draw. This email address will not be connected with the results of your questionnaire. Record of your email address will be destroyed after the draw has taken place.

Once the study is complete, an archive of the data, without identifying information, will be kept offline in a secure location on McMaster University campus for 10 years, where only the researchers will have access to it. After this period it will be destroyed.

What if I change my mind about being in the study?

Your participation in this study is voluntary. During the questionnaire, you can stop anytime you want, for any reason, even after agreeing to the consent form. Just click on the "Withdraw" button, or close your browser window. Your answers to that point will be discarded.

Once you have submitted your responses for this anonymous survey, your answers will be put into a database and will not be identifiable to you. This means that once you have submitted your survey, your responses cannot be withdrawn from the study because we will not be able to identify which responses are yours.

Your decision whether or not to be part of the study will not affect your status as a professional, as an employee or within the paramedicine community in any way.

Withdrawing from the study will also not affect your ability to enter into the draw.

How do I find out what was learned in this study?

I expect to have this study completed by approximately June of 2015. A summary of the results will be posted at http://emsstudy.com. If you would like to receive the summary personally, please let me know how you would like me to send it to you.

Questions about the Study

If you have questions or need more information about the study itself, please contact me by email at dohanms@mcmaster.ca.

This study has been reviewed by the McMaster University Research Ethics Board and received ethics clearance. If you have concerns or questions about your rights as a participant or about the way the study is conducted, please contact:

McMaster Research Ethics Secretariat
Telephone: (905) 525-9140 ext. 23142
C/o Research Office for Administrative Development and Support
E-mail: ethicsoffice@mcmaster.ca

Consent *[Note: Consent will be obtained online at the study website]*

If you wish to participate, please verify the following:

- ✓ I am a paramedic currently employed by a Canadian Land Ambulance Service.

- ✓ I have read the information presented in the information letter about a study being conducted by Joseph Tan and Michael S. Dohan of DeGroote School of Business, McMaster University.
- ✓ I have had the opportunity to ask questions about my involvement in this study and to receive additional details I requested.
- ✓ I understand that if I agree to participate in this study, I may withdraw from the study only before I submit my anonymous survey results.
- ✓ I have been provided a copy of this form.
- ✓ I agree to participate in the study.

The following are optional:

- ✓ I would like to receive a copy of the study results. [PLEASE ENTER EMAIL]

[CLICK TO BEGIN THE STUDY]

Recruitment Poster

McMaster University

PARAMEDIC PARTICIPANTS NEEDED

We are looking for volunteers to take part in a study of Land Ambulance Services' ability to develop innovative service delivery models.

You would be asked to complete an anonymous self-assessment of your skills and knowledge with using technology in a healthcare environment.

Your participation would involve filling out an anonymous online survey, which should take approximately 15-20 minutes. You can complete this survey at a time that is convenient for you.

In appreciation for your time, you will be entered into a draw for a gift worth $500
(1 in 500 chances to win).

For more information, or to participate in the study, please visit this website:

http://emsstudy.com/paramedic

This study is conducted by:
Michael S. Dohan, PhD Candidate
DeGroote School of Business, McMaster University
(807) 630-4426 or dohanms@mcmaster.ca

This study has been reviewed by, and received ethics clearance by the McMaster Research Ethics Board.

$500 prize http://emsstudy.com/paramedic

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$500 prize http://emsstudy.com/paramedic

Demographic Items

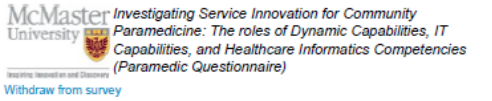
Item	Hint	Answer Format
Please enter the name of your service	Example: Superior North EMS, Toronto EMS, Winnipeg Fire Paramedic Service, EMS in the Calgary Zone	Short Text
Gender		Male/Female/No Answer
Years Experience		Number, at least zero
Rank	Examples: PCP, ACP, etc	Short Text
How familiar are you with the concept of Community Paramedicine?		Very Familiar, Somewhat Familiar, Not Very Familiar, Not at all familiar, no answer
% of time spent performing Community Paramedicine duties	If you are not sure or don't know, enter -1	Number
Describe any Community Paramedicine duties that you have/currently perform	If not applicable, leave blank	Long Text
Describe any Community Paramedicine-specific training that you have undertaken	If not applicable, leave blank	Long Text
List the software applications that you use for work.	This can include an eACR or other technologies. If you know the name of the application (eg. iMedic), please enter that.	Long Text

Instrument. All items are self-evaluated: 0 not aware; 1 aware; 2 aware to knowledgeable; 3 knowledgeable; 4 knowledgeable to proficient; 5 proficient.

EUInfo1	Evaluate the integrity and comparability of data and identify gaps in data sources
EUInfo2	Obtain and interpret information regarding risks and benefits to the community
EUInfo3	Collect, summarize, and interpret information relevant to an issue
EUInfo4	Use the media, advanced technologies, and community networks to communicate
EUInfo5	Effectively present accurate demographic, statistical, programmatic, and scientific information for professional and lay audiences
EUInfo6	Develop, implement, and evaluate a community public health assessment
EUInfo7	Identify and retrieve current relevant scientific evidence
EUTech1	Utilize modern information technology tools to identify, locate, and appropriately interpret and use online public health information and data

EUTech2	Use browser software to navigate the World Wide Web
EUTech3	Use general-purpose online search engines to search the Web (e.g., Google, Yahoo!)
EUTech4	Identify relevant special-purpose search engines and use those search engines to retrieve public health-specific information and data
EUTech5	Assess the validity and authoritativeness of data and information retrieved from online sources
EUTech6	Utilize modern information technology as a tool to promote public health
EUTech7	Design an agency/organization website that helps users find health-related information
EUTech8	Use information technologies to broadcast health-related news, alerts, and advisories to community members, legislators and other policy makers, news media, and others
EUTech9	Identify the wide array of information sources that are potentially relevant to public health
EUTech10	Find online data and information from multiple sources
EUTech11	Appropriately combine, interpret, and utilize data and information from multiple sources to create new information and knowledge
EUTech12	Characteristics, functionalities and examples of information systems to support patients and the public (e.g. patient-oriented information system architectures and applications, personal health records, sensor-enhanced information systems)
EMProj1	Describe at a basic level the fundamentals of a computer network
EMProj2	Describe at a basic level the Internet and World Wide Web
EMProj3	Describe at a basic level technologies employed to ensure computer systems' security
EMProj4	Describe new information technologies and how they might be employed to improve public health practice
EMProj5	Name the technologies currently available for delivering distance learning materials to the learner
EMProj6	Monitor informatics and public health information systems development efforts, and apply these findings and experiences as appropriate to public health practice
EMProj7	Identify the major information systems' development efforts that are likely to impact public health practice
EMProj8	Regularly scan appropriate scientific and practice literature for information technology developments and applications to public health

Layout Page 1



Investigating Service Innovation for Community Paramedicine: The roles of Dynamic Capabilities, IT Capabilities, and Healthcare Informatics Competencies (Paramedic Questionnaire)

Withdraw from survey

25%

Thank you for agreeing to participate. Please rate your proficiency of the following items.

Utilize modern information technology tools to identify, locate, and appropriately interpret and use online public health information and data

Not Aware | Aware | Aware to Knowledgeable | Knowledgeable | Knowledgeable to Proficient | Proficient | N/A / No Answer

Appropriately combine, interpret, and utilize data and information from multiple sources to create new information and knowledge

Not Aware | Aware | Aware to Knowledgeable | Knowledgeable | Knowledgeable to Proficient | Proficient | N/A / No Answer

Describe new information technologies and how they might be employed to improve public health practice

Not Aware | Aware | Aware to Knowledgeable | Knowledgeable | Knowledgeable to Proficient | Proficient | N/A / No Answer

Collect, summarize, and interpret information relevant to an issue

Not Aware | Aware | Aware to Knowledgeable | Knowledgeable | Knowledgeable to Proficient | Proficient | N/A / No Answer

Use the media, advanced technologies, and community networks to communicate

Not Aware | Aware | Aware to Knowledgeable | Knowledgeable | Knowledgeable to Proficient | Proficient | N/A / No Answer

Describe at a basic level the Internet and World Wide Web

Not Aware | Aware | Aware to Knowledgeable | Knowledgeable | Knowledgeable to Proficient | Proficient | N/A / No Answer

Describe at a basic level technologies employed to ensure computer systems' security

Not Aware Aware Aware to Knowledgeable Knowledgeable
Knowledgeable to Proficient Proficient N/A / No Answer

Evaluate the integrity and comparability of data and identify gaps in data sources

Not Aware Aware Aware to Knowledgeable Knowledgeable
Knowledgeable to Proficient Proficient N/A / No Answer

Use information technologies to broadcast health-related news, alerts, and advisories to community members, legislators and other policy makers, news media, and others

Not Aware Aware Aware to Knowledgeable Knowledgeable
Knowledgeable to Proficient Proficient N/A / No Answer

Describe at a basic level the fundamentals of a computer network

Not Aware Aware Aware to Knowledgeable Knowledgeable
Knowledgeable to Proficient Proficient N/A / No Answer

Use browser software to navigate the World Wide Web

Not Aware Aware Aware to Knowledgeable Knowledgeable
Knowledgeable to Proficient Proficient N/A / No Answer

Find online data and information from multiple sources

Not Aware Aware Aware to Knowledgeable Knowledgeable
Knowledgeable to Proficient Proficient N/A / No Answer

Identify the major information systems' development efforts that are likely to impact public health practice

Not Aware Aware Aware to Knowledgeable Knowledgeable
Knowledgeable to Proficient Proficient N/A / No Answer

Use general-purpose online search engines to search the Web (e.g., Google, Yahoo!)

Not Aware Aware Aware to Knowledgeable Knowledgeable
Knowledgeable to Proficient Proficient N/A / No Answer

Obtain and interpret information regarding risks and benefits to the community

Not Aware Aware Aware to Knowledgeable Knowledgeable
Knowledgeable to Proficient Proficient N/A / No Answer

Monitor informatics and public health information systems development efforts, and apply these findings and experiences as appropriate to public health practice

Not Aware Aware Aware to Knowledgeable Knowledgeable
Knowledgeable to Proficient Proficient N/A / No Answer

Identify relevant special-purpose search engines and use those search engines to retrieve public health-specific information and data

Not Aware Aware Aware to Knowledgeable Knowledgeable
Knowledgeable to Proficient Proficient N/A / No Answer

Identify the wide array of information sources that are potentially relevant to public health

Not Aware Aware Aware to Knowledgeable Knowledgeable
Knowledgeable to Proficient Proficient N/A / No Answer

Assess the validity and authoritativeness of data and information retrieved from online sources

Not Aware Aware Aware to Knowledgeable Knowledgeable
Knowledgeable to Proficient Proficient N/A / No Answer

Name the technologies currently available for delivering distance learning materials to the learner

Not Aware Aware Aware to Knowledgeable Knowledgeable
Knowledgeable to Proficient Proficient N/A / No Answer

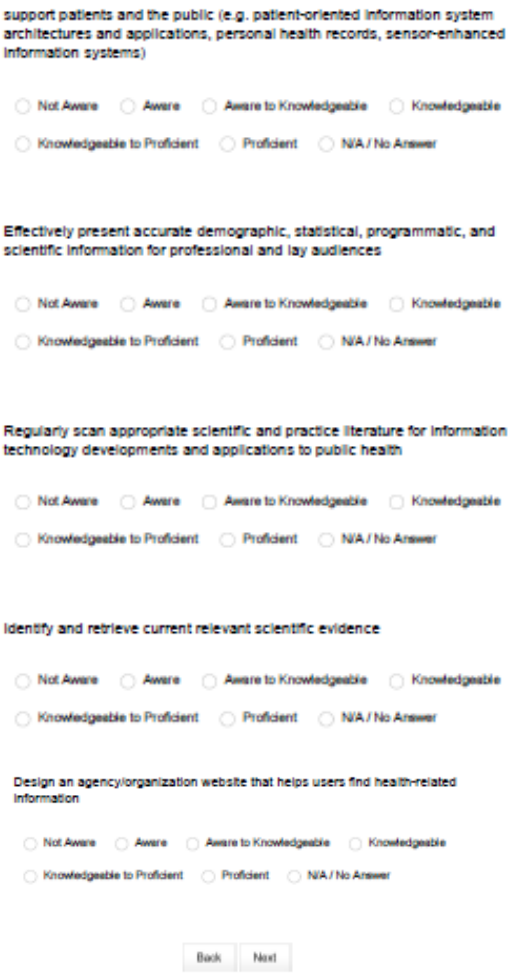
Develop, implement, and evaluate a community public health assessment

Not Aware Aware Aware to Knowledgeable Knowledgeable
Knowledgeable to Proficient Proficient N/A / No Answer

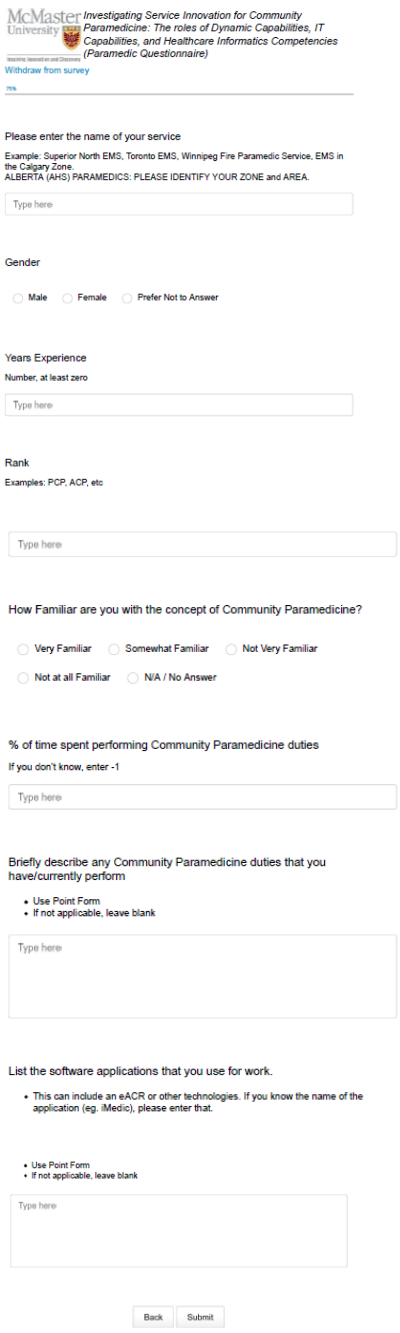
Utilize modern information technology as a tool to promote public health

Not Aware Aware Aware to Knowledgeable Knowledgeable
Knowledgeable to Proficient Proficient N/A / No Answer

Characteristics, functionalities and examples of information systems to


support patients and the public (e.g. patient-oriented information system architectures and applications, personal health records, sensor-enhanced information systems)
Not Aware
Aware
Aware to Knowledgeable
Knowledgeable
Knowledgeable to Proficient
Proficient
N/A / No Answer
Effectively present accurate demographic, statistical, programmatic, and scientific information for professional and lay audiences
Not Aware
Aware
Aware to Knowledgeable
Knowledgeable
Knowledgeable to Proficient
Proficient
N/A / No Answer
Regularly scan appropriate scientific and practice literature for information technology developments and applications to public health
Not Aware
Aware
Aware to Knowledgeable
Knowledgeable
Knowledgeable to Proficient
Proficient
N/A / No Answer
Identify and retrieve current relevant scientific evidence
Not Aware
Aware
Aware to Knowledgeable
Knowledgeable
Knowledgeable to Proficient
Proficient
N/A / No Answer
Design an agency/organization website that helps users find health-related information
Not Aware
Aware
Aware to Knowledgeable
Knowledgeable
Knowledgeable to Proficient
Proficient
N/A / No Answer
Back
Next

Layout Page 2



McMaster University

Investigating Service Innovation for Community Paramedicine: The roles of Dynamic Capabilities, IT Capabilities, and Healthcare Informatics Competencies (Paramedic Questionnaire)

Withdraw from survey

0%

Please enter the name of your service

Example: Superior North EMS, Toronto EMS, Winnipeg Fire Paramedic Service, EMS in the Calgary Zone.
ALBERTA (AHS) PARAMEDICS: PLEASE IDENTIFY YOUR ZONE and AREA.

Type here

Gender

Male Female Prefer Not to Answer

Years Experience

Number, at least zero

Type here

Rank

Examples: PCP, ACP, etc

Type here

How Familiar are you with the concept of Community Paramedicine?

Very Familiar Somewhat Familiar Not Very Familiar
Not at all Familiar N/A / No Answer

% of time spent performing Community Paramedicine duties

If you don't know, enter -1

Type here

Briefly describe any Community Paramedicine duties that you have/currently perform

- Use Point Form
- If not applicable, leave blank

Type here

List the software applications that you use for work.

- This can include an eACR or other technologies. If you know the name of the application (eg. iMedic), please enter that.

- Use Point Form
- If not applicable, leave blank

Type here

Back Submit

Layout Finished Page

Appendix B – Factor Loadings for HIC Items

This is the original results for the EFA on the HIC items. Factor loadings less than 0.5 are suppressed. Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. Rotation converged in 20 iterations.

	Component		
	1	2	3
euinfo1	.574		
euinfo2	.677		
euinfo3	.700		
euinfo4			
euinfo5	.584		
euinfo6		.641	
euinfo7	.713		
eutech1	.537		
eutech2			.786
eutech3			.769
eutech4	.565		
eutech5	.673		
eutech6		.537	
eutech7		.764	
eutech8		.556	
eutech9	.566		
eutech10	.530		.626
eutech11	.754		
eutech12		.645	
emproj1		.600	.552
emproj2			.741
emproj3		.651	
emproj4		.629	
emproj5		.574	
emproj6		.610	
emproj7		.713	
emproj8	.572		

Appendix C – Paramedic Leader Instrument and Recruitment Material

Email Script Template. This script is to be sent from each sponsor to Paramedic Leaders in their professional associations. This script is to be sent from each Paramedic Leader to the other Paramedic Leaders in the various associations (OAPC, EMSCC, etc), therefore it is expected that some appropriate customization must be allowed. This script contains 4 emails: one initial, and 3 follow ups.

Initial E-mail Subject line: Research Call for Participation - Service Innovation for Community Paramedicine

Dear Colleagues,

As you may know, it is increasingly a goal for paramedicine to collaborate with researchers in order to work towards addressing issues important to paramedicine. Through a professional connection, I have recently been presented with an opportunity that will contribute important knowledge to our practice, and is timely, considering the emergence of Community Paramedicine.

Mr. Michael Dohan, a doctoral student in Business Administration at McMaster University, is recruiting Paramedic Leaders for a study on how the ability of a Land Ambulance Service (LAS) to exploit technology impacts the ability of an LAS to develop innovative service delivery models. The field of paramedicine may benefit from this study by underlining the importance of technology as we implement locally-relevant and impactful Community Paramedicine initiatives.

Mr. Dohan is requesting your participation in this study. This study is seeking Paramedic Leaders that typically oversee the day-to-day operations of a Canadian LAS. This study would

like to recruit 1 Paramedic Leader and several paramedics per service. You will need to fill out a questionnaire, and then distribute recruitment material to paramedics throughout their organization. The questionnaire should take about 30 minutes of your time, and recruiting will involve the display of posters and sending no more than 4 recruitment emails to your paramedics.

For your contribution, you will be offered a confidential custom report, benchmarking variables related to innovation performance as well as ability to exploit technology against others in the sample.

This study has been reviewed and cleared by the McMaster Research Ethics Board. If you have questions or concerns about your rights as a participant or about the way the study is being conducted you may contact:

McMaster Research Ethics Board Secretariat

Telephone: (905) 525-9140 ext. 23142

Gilmour Hall – Room 305 (ROADS)

E-mail: ethicsoffice@mcmaster.ca

Attached are copies of the recruitment material, letters of information, and a sample performance report. If you are interested in Mr. Dohan's study please visit this link: http://emsstudy.com/paramedicleader

You can also CONTACT MICHAEL DIRECTLY by phone or email address. Tel: 807-630-4426 or dohanms@mcmaster.ca.

Sincerely,

[name, title, organization]

First/Second Follow Up

Initial E-mail Subject line: FOLLOW UP: Research Call for Participation - Service Innovation for Community Paramedicine

Dear Colleagues,

This email is a follow up from a previous email.

As you may know, it is increasingly a goal for paramedicine to collaborate with researchers in order to work towards addressing issues important to paramedicine. Through a professional connection, I have recently been presented with an opportunity that will contribute important knowledge to our practice, and is timely, considering the emergence of Community Paramedicine.

Mr. Michael Dohan, a doctoral student in Business Administration at McMaster University, is recruiting Paramedic Leaders for a study on how the ability of a Land Ambulance Service (LAS) to exploit technology impacts the ability of an LAS to develop innovative service delivery models. The field of paramedicine may benefit from this study by underlining the importance of technology as we implement locally-relevant and impactful Community Paramedicine initiatives.

Mr. Dohan is requesting your participation in this study. This study is seeking Paramedic Leaders that typically oversee the day-to-day operations of a Canadian LAS. This study would like to recruit 1 Paramedic Leader and several paramedics per service. You will need to fill out a questionnaire, and then distribute recruitment material to paramedics throughout their organization. The questionnaire should take about 30 minutes of your time, and recruiting will involve the display of posters and sending no more than 4 recruitment emails to your paramedics.

For your contribution, you will be offered a confidential custom report, benchmarking variables related to innovation performance as well as ability to exploit technology against others in the sample.

This study has been reviewed and cleared by the McMaster Research Ethics Board. If you have questions or concerns about your rights as a participant or about the way the study is being conducted you may contact:

McMaster Research Ethics Board Secretariat

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E-mail: ethicsoffice@mcmaster.ca

Attached are copies of the recruitment material, letters of information, and a sample performance report. If you are interested in Mr. Dohan's study please visit this link: http://emsstudy.com/paramedicleader

You can also **CONTACT MICHAEL DIRECTLY** by phone or email address. **Tel: 807-630-4426** or dohanms@mcmaster.ca.

Sincerely,

[name, title, organization]

Final Follow Up

Initial E-mail Subject line: LAST CHANCE: Research Call for Participation - Service Innovation for Community Paramedicine

Dear Colleagues,

This email is the final follow up from previous emails.

As you may know, it is increasingly a goal for paramedicine to collaborate with researchers in order to work towards addressing issues important to paramedicine. Through a professional connection, I have recently been presented with an opportunity that will contribute important knowledge to our practice, and is timely, considering the emergence of Community Paramedicine.

Mr. Michael Dohan, a doctoral student in Business Administration at McMaster University, is recruiting Paramedic Leaders for a study on how the ability of a Land Ambulance Service (LAS) to exploit technology impacts the ability of an LAS to develop innovative service delivery models. The field of paramedicine may benefit from this study by underlining the importance of technology as we implement locally-relevant and impactful Community Paramedicine initiatives.

Mr. Dohan is requesting your participation in this study. This study is seeking Paramedic Leaders that typically oversee the day-to-day operations of a Canadian LAS. This study would like to recruit 1 Paramedic Leader and several paramedics per service. You will need to fill out a questionnaire, and then distribute recruitment material to paramedics throughout their organization. The questionnaire should take about 30 minutes of your time, and recruiting will involve the display of posters and sending no more than 4 recruitment emails to your paramedics.

For your contribution, you will be offered a confidential custom report, benchmarking variables related to innovation performance as well as ability to exploit technology against others in the sample.

This study has been reviewed and cleared by the McMaster Research Ethics Board. If you have questions or concerns about your rights as a participant or about the way the study is being conducted you may contact:

McMaster Research Ethics Board Secretariat

Telephone: (905) 525-9140 ext. 23142

Gilmour Hall – Room 305 (ROADS)

Email: ethicsoffice@mcmaster.ca

Attached are copies of the recruitment material, letters of information, and a sample performance report. If you are interested in Mr. Dohan's study please visit this link: http://emsstudy.com/paramedicleader

You can also **CONTACT MICHAEL DIRECTLY** by phone or email address. **Tel: 807-630-4426** or dohanms@mcmaster.ca.

Sincerely,

[name, title, organization]

Letter of Information

Investigating Service Innovation for Community Paramedicine: The roles of Dynamic Capabilities, IT Capabilities, and Healthcare Informatics Competencies

Principal Investigator:
Dr. Joseph Tan
DeGroote School of Business
McMaster University
Hamilton, Ontario, Canada
(905) 525-9140 ext. 26166
E-mail: tanjosep@mcmaster.ca

Student Investigator:
Mr. Michael Dohan
DeGroote School of Business
McMaster University
Hamilton, Ontario, Canada
(807) 630 4426
E-mail: dohanms@mcmaster.ca

Purpose of the Study

The purpose of the survey is to investigate how the ability of a Land Ambulance Service (LAS) to exploit technology impacts the ability of an LAS to develop innovative service delivery models. This research is being conducted as part of Mr. Dohan's doctoral dissertation for his PhD in Business Administration.

We invite paramedic leaders who oversee the day-to-day operations of a Canadian Land Ambulance Services to take part in this study. Examples of these positions would be Chiefs of EMS (in Ontario), Zone Executive Directors (in Alberta), or equivalents.

As this study involves collecting survey data from both paramedic leaders and paramedics, you would have to be willing to distribute recruitment material to the paramedics in your organization.

Procedures involved in the Research

There are two steps in this research:

STEP 1: QUESTIONNAIRE

First, you will need to fill out a questionnaire. The questionnaire should take about 30 minutes of your time.

The survey contains questions that pertain to your organization, its capabilities with using information technology, and its innovation performance. Below are sample questions:

- When setting strategy, I appreciate those responsible for the management of our IT resources.
- As compared to other paramedic services, what is the level of your services' innovation efforts in meeting citizens' needs?
- We are forthcoming in contributing our individual input to the group.

STEP 2: RECRUIT PARAMEDICS FROM YOUR OWN ORGANIZATION
Second, you will help recruit paramedics in your own LAS by distributing recruitment material throughout your organization.

Recruiting will involve the display of posters and sending no more than 4 recruitment emails to your paramedics.

Here is a sample poster: http://linktoposter.

Are there any risks to doing this study?

It is not likely that there will be any harms or discomforts associated with participating in this study.

You do not need to answer questions that you do not want to answer or that make you feel uncomfortable. I describe below the steps I am taking to protect your privacy.

People in your organization will be aware that you have participated in the survey. However, nobody but the researchers will know what you have answered. When the results are published, you nor any other individual will be identified in the results.

As well, the paramedic survey contains questions that pertain to the self-evaluation of their own knowledge and skills related to using technology in a healthcare environment. They will not be evaluating you or their organization as part of this research. A copy of the paramedic survey is available at **http://emsstudy.com/paramedicleader**

Are there any benefits to doing this study?

The research itself will not benefit you directly. We hope to learn more about how paramedics can contribute to organizational activities related to developing and implementing innovative service delivery models. This could help determine an important driver of performance improvement and improving the well-being of the citizens you serve.

Payment or Reimbursement

You can choose to receive a confidential customized report, allowing you to compare your performance in this survey with the sample. A sample prototype of the report is available at **http://emsstudy.com/.** If you would like a copy of this, you will need to provide information on how the report can be sent to you in a secure manner.

Who will know what I said or did in the study?

Although members of your organization will be aware that you have participated in the study, your information will remain confidential. Your answers will be kept on a secure server where only the researchers will have access to this data.

When the final report is created from this data, you will not be identified.

Once the study is complete, an archive of the data, without identifying information, will be kept offline in a secure location on McMaster University campus for 10 years, where only the researchers will have access to it. After this period it will be destroyed.

What if I change my mind about being in the study?

Your participation in this study is voluntary. During the questionnaire, you can stop anytime you want, for any reason, even after agreeing to the consent form. Just click on the "Withdraw" button, or close your browser window. Your answers to that point will be discarded.

After you have submitted the questionnaire, you can still withdraw from the research. You can tell your paramedics to cease participating in this study, and remove any recruiting posters that you had displayed. As well, to ensure that the data that you and your paramedics have submitted is destroyed, please send a courtesy email to the student investigator (dohanms@mcmaster.ca) indicating that you wish to withdraw.

If you withdraw, you will not be able to receive a customized report, as it would be contingent on your participating.

Your decision whether or not to be part of the study will not affect your status as a professional, as an employee or within the paramedicine community in any way.

How do I find out what was learned in this study?

I expect to have this study completed by approximately June of 2015. A summary of the results will be posted at http://www.emsstudy.com. If you would like to receive the summary personally, please let me know how you would like me to send it to you.

Questions about the Study

If you have questions or need more information about the study itself, please contact me by email at dohanms@mcmaster.ca.

This study has been reviewed by the McMaster University Research Ethics Board and received ethics clearance. If you have concerns or questions about your rights as a participant or about the way the study is conducted, please contact:

McMaster Research Ethics Secretariat
Telephone: (905) 525-9140 ext. 23142
C/o Research Office for Administrative Development and Support
E-mail: ethicsoffice@mcmaster.ca

Consent *[Note: Consent will be obtained online at the study website]*

If you wish to participate, please verify the following:

- ✓ I am a paramedic leader currently overseeing day-to-day operations at a Canadian Land Ambulance Service.
- ✓ I have read the information presented in the information letter about a study being conducted by Joseph Tan and Michael S. Dohan of DeGroote School of Business, McMaster University.
- ✓ I have had the opportunity to ask questions about my involvement in this study, as well as the involvement of the paramedics at my LAS. I have had the opportunity to receive additional details I requested.
- ✓ I understand that if I agree to participate in this study, I can withdraw at any time. I can send a courtesy notice to the student investigator to ensure that my questionnaire data and the data from my LAS has been destroyed. I can inform the paramedics at my organization to cease participation and remove any posters that I had previously displayed.
- ✓ I have been provided a copy of this form.
- ✓ I agree to participate in the study.

The following are optional:

- ✓ I would like to receive a copy of the study results. [PLEASE ENTER EMAIL]
  - o I would like to receive a customized report, benchmarking my performance against the sample [ENTER INSTRUCTIONS WHERE THIS REPORT CAN BE SENT SECURELY]

[CLICK TO BEGIN THE STUDY]

Demographic Questions.

Item	Hint	Answer Format
Your title	Examples: Chief of EMS, Deputy Chief of EMS, Zone Executive Director	Short Text
Your rank	Examples: PCP, ACP	Short Text
Your gender		Male/Female/No Answer
Years In Position		Number
Please Enter the Name of your Service		Short Text
Province/Territory	Select one choice	AB, BC, etc
Overseeing Body	Select one choice	Social Services Administration Board Hospital

		Health Region/Regional Health Authority City/Municipality Territory Province County/District/Region First Nations Fire Service No answer
# of Active Paramedics (by classification)	Example: 15 ACPs, 70 PCPs, etc.	Long Text
# of Personnel that partially conduct CP activities		Integer, At Least Zero
# of Dedicated CP Personnel		Integer, At Least Zero
# of total staffing hours (annual, 2013)		Integer, At Least Zero
# of staffing hours dedicated to CP (annual, 2013)		Integer, At Least Zero
% Rural by Call Volume (emergency)		Integer, between 0 and 100
% Rural by Area served (geographical)		Integer, between 0 and 100
Years offering CP services	For portions of year, use decimal numbers. If you don't offer any CP services, enter "0"	Number, at least zero
$ Funding for CP services (2013)		Number, at least zero
$ Funding for Technology (2013)		Number, at least zero
$ Funding for IT Training (2013)		Number, at least zero
List the types of CP services you currently provide	Example: Home visits for the elderly, Chronic Disease education, etc	Long Text

Instrument.

Item	Text	Answer
Sense1	When scanning the environment to identify gaps in service delivery, we are:	[1-7] (effective – not effective)

Sense2	When reviewing the likely effect of changes in our service delivery model on patients, we are:	[1-7] (effective – not effective)
Sense3	When reviewing our service delivery models to ensure they are in line with the needs of the citizens we serve, we are:	[1-7] (effective – not effective)
Sense4	When finding time for implementing ideas for new service delivery models and improving our existing service delivery models, we are:	[1-7] (effective – not effective)
Learn1	Our routines to identify, value, and import new information and knowledge are:	[1-7] (effective – not effective)
Learn2	Our routines to assimilate new information and knowledge are:	[1-7] (effective – not effective)
Learn3	Our abilities for transforming existing information into new knowledge are:	[1-7] (effective – not effective)
Learn4	Our abilities to use knowledge in new service delivery models are:	[1-7] (effective – not effective)
Learn5	Our abilities for developing new knowledge that has the potential to influence service delivery are:	[1-7] (effective – not effective)
Integrate1	Our abilities to be forthcoming in contributing individual input to group discussions are:	[1-7] (effective – not effective)
Integrate2	Our global understanding of each other's tasks and responsibilities is:	[1-7] (effective – not effective)
Integrate3	In being aware of who in our service has specialized skills and knowledge relevant to our work, we are:	[1-7] (effective – not effective)
Integrate4	When interrelating our actions to each other to meet changing conditions, we are:	[1-7] (effective – not effective)
Integrate5	When group members attempt to interconnect their activities, they are:	[1-7] (effective – not effective)
Coord1	When ensuring that the output of our work is synchronized with the work of others, we are:	[1-7] (effective – not effective)
Coord2	When allocating resources (e.g., information, time, reports) within our service, we are:	[1-7] (effective – not effective)
Coord3	With regards to assigning employees to tasks commensurate with their task-relevant knowledge and skills, we are:	[1-7] (effective – not effective)
Coord4	When ensuring that there is compatibility between group members expertise and work processes, we are:	[1-7] (effective – not effective)
Coord5	The overall coordination of our group is:	[1-7] (effective – not effective)
Reconfig1	When we re-deploy our resources to improve system performance, we are:	[1-7] (effective – not effective)
Reconfig2	When we engage in re-deployment to better match changes in demand, we are:	[1-7] (effective – not effective)

Integration1	We engage in information sharing with other organizations (ie healthcare, social services) through information technologies.	[1
Integration2	What is the degree of strategic partnership between your LAS and other organizations (ie healthcare, social services)?	[1-7] (extremely low – extremely high)
Integration3	We engage in joint planning with other organizations (ie healthcare, social services).	[1-7] (extremely low – extremely high)
Integration4	We use information, provided by other organizations (ie healthcare, social services), that is valuable in conducting day-to-day operations	[1-7] (extremely low – extremely high)
Integration5	We involve other organizations (ie healthcare, social services) in service delivery model development processes at our organization.	[1-7] (extremely low – extremely high)
ITBusExp1	The personnel that supply information technology (IT) services for our organization understand our organization's policies and plans at a very high level.	[1-7] (agree-disagree)
ITBusExp2	The personnel that supply information technology (IT) services for our organization are very capable in interpreting business problems and developing appropriate technical solutions.	[1-7] (agree-disagree)
ITBusExp3	The personnel that supply information technology (IT) services for our organization are very knowledgeable about business functions.	[1-7] (agree-disagree)
ITBusExp4	The personnel that supply information technology (IT) services for our organization are very knowledgeable about the business environment.	[1-7] (agree-disagree)
Relinf1	When setting strategy, I trust those responsible for the management of our IT resources.	[1-7] (agree-disagree)
Relinf2	When setting strategy, I appreciate those responsible for the management of our IT resources.	[1-7] (agree-disagree)
Relinf3	When setting strategy, I consult with those responsible for the management of our IT resources.	[1-7] (agree-disagree)
Relinf4	When setting strategy, I respect those responsible for the management of our IT resources.	[1-7] (agree-disagree)
Relinf5	When setting strategy, I accept some accountability for the success of IT projects.	[1-7] (agree-disagree)
SIP1	As compared to other paramedic services, what is the level of your services' innovation efforts in meeting citizens' needs?	1 (very low) to 7 (very high)

SIP2	As compared to other paramedic services, what is the level of your service's success rate in implementing innovations in the past 3 years?	1 (very low) to 7 (very high)
SIP3	As compared to other paramedic services, what is the level of your services' overall service innovation performance in the past 3 years?	1 (very low) to 7 (very high)
SIP4	As compared to other paramedic services, what is the percentage of performance improvement attributable to service innovation in the past 3 years?	1 (very low) to 7 (very high)

Layout Page 1

Investigating Service Innovation for Community Paramedicine: The roles of Dynamic Capabilities, IT Capabilities, and Healthcare Informatics Competencies (Paramedic Leader Questionnaire)

Withdraw from survey

When group members attempt to interconnect their activities, they are:

- Very Effective
- Somewhat Effective
- Uncertain
- Not Very Effective
- Not At All Effective
- N/A/No Answer

Our routines to identify, value, and import new information and knowledge are:

- Very Effective
- Somewhat Effective
- Uncertain
- Not Very Effective
- Not At All Effective
- N/A/No Answer

We engage in joint planning with other organizations (ie healthcare, social services).

- Very High Amount
- High Amount
- Medium Amount
- Low Amount
- Very Low Amount
- N/A/No Answer

We involve other organizations (ie healthcare, social services) in service delivery model development processes at our organization.

- ◯ Very High Amount
- ◯ High Amount
- ◯ Medium Amount
- ◯ Low Amount
- ◯ Very Low Amount
- ◯ N/A/No Answer

When reviewing the likely effect of changes in our service delivery model on patients, we are:

- ◯ Very Effective
- ◯ Somewhat Effective
- ◯ Uncertain
- ◯ Not Very Effective
- ◯ Not At All Effective
- ◯ N/A/No Answer

As compared to other paramedic services, what is the level of your services' innovation efforts in meeting citizens' needs?

- ◯ Very High
- ◯ High
- ◯ Medium
- ◯ Low
- ◯ Very Low
- ◯ N/A/No Answer

When setting strategy, I appreciate those responsible for the management of our IT resources.

Strongly Agree Agree Neutral Disagree

Strongly Disagree N/A/No Answer

The personnel that supply information technology (IT) services for our organization are very knowledgeable about business functions.

Strongly Agree Agree Neutral Disagree

Strongly Disagree N/A/No Answer

When allocating resources (e.g., information, time, reports) within our service, we are:

Very Effective Somewhat Effective Uncertain

Not Very Effective Not At All Effective N/A/No Answer

Our abilities to use knowledge in new service delivery models are:

Very Effective Somewhat Effective Uncertain

Not Very Effective Not At All Effective N/A/No Answer

The overall coordination of our group is:

- Very Effective
- Somewhat Effective
- Uncertain
- Not Very Effective
- Not At All Effective
- N/A/No Answer

Our global understanding of each other's tasks and responsibilities is:

- Very Effective
- Somewhat Effective
- Uncertain
- Not Very Effective
- Not At All Effective
- N/A/No Answer

As compared to other paramedic services, what is the level of your service's success rate in implementing innovations in the past 3 years?

- Very High
- High
- Medium
- Low
- Very Low
- N/A/No Answer

When setting strategy, I accept some accountability for the success of IT projects.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree
- N/A/No Answer

Our routines to assimilate new information and knowledge are:

- ◯ Very Effective
- ◯ Somewhat Effective
- ◯ Uncertain
- ◯ Not Very Effective
- ◯ Not At All Effective
- ◯ N/A/No Answer

We use information, provided by other organizations (ie healthcare, social services), that is valuable in conducting day-to-day operations

- ◯ Very High Amount
- ◯ High Amount
- ◯ Medium Amount
- ◯ Low Amount
- ◯ Very Low Amount
- ◯ N/A/No Answer

When reviewing our service delivery models to ensure they are in line with the needs of the citizens we serve, we are:

- ◯ Very Effective
- ◯ Somewhat Effective
- ◯ Uncertain
- ◯ Not Very Effective
- ◯ Not At All Effective
- ◯ N/A/No Answer

When setting strategy, I trust those responsible for the management of our IT resources.

- ◯ Strongly Agree
- ◯ Agree
- ◯ Neutral
- ◯ Disagree
- ◯ Strongly Disagree
- ◯ N/A/No Answer

When setting strategy, I consult with those responsible for the management of our IT resources.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree
- N/A/No Answer

In being aware of who in our service has specialized skills and knowledge relevant to our work, we are:

- Very Effective
- Somewhat Effective
- Uncertain
- Not Very Effective
- Not At All Effective
- N/A/No Answer

We engage in information sharing with other organizations (ie healthcare, social services) through information technologies.

- Very High Amount
- High Amount
- Medium Amount
- Low Amount
- Very Low Amount
- N/A/No Answer

The personnel that supply information technology (IT) services for our organization understand our organization's policies and plans at a very high level.

Strongly Agree Agree Neutral Disagree

Strongly Disagree N/A/No Answer

When scanning the environment to identify gaps in service delivery, we are:

Very Effective Somewhat Effective Uncertain

Not Very Effective Not At All Effective N/A/No Answer

Our abilities for transforming existing information into new knowledge are:

Very Effective Somewhat Effective Uncertain

Not Very Effective Not At All Effective N/A/No Answer

Our abilities to be forthcoming in contributing individual input to group discussions are:

Very Effective Somewhat Effective Uncertain

Not Very Effective Not At All Effective N/A/No Answer

When ensuring that the output of our work is synchronized with the work of

others, we are:

- ◯ Very Effective
- ◯ Somewhat Effective
- ◯ Uncertain
- ◯ Not Very Effective
- ◯ Not At All Effective
- ◯ N/A/No Answer

When we re-deploy our resources to improve system performance, we are:

- ◯ Very Effective
- ◯ Somewhat Effective
- ◯ Uncertain
- ◯ Not Very Effective
- ◯ Not At All Effective
- ◯ N/A/No Answer

When setting strategy, I respect those responsible for the management of our IT resources.

- ◯ Strongly Agree
- ◯ Agree
- ◯ Neutral
- ◯ Disagree
- ◯ Strongly Disagree
- ◯ N/A/No Answer

What is the degree of strategic partnership between your LAS and other organizations (ie healthcare, social services)?

- ◯ Very High Degree
- ◯ High Degree
- ◯ Medium Degree
- ◯ Low Degree
- ◯ Very Low Degree
- ◯ N/A/No Answer

As compared to other paramedic services, what is the percentage of performance improvement attributable to service innovation in the past 3 years?

- Very High
- High
- Medium
- Low
- Very Low
- N/A/No Answer

With regards to assigning employees to tasks commensurate with their task-relevant knowledge and skills, we are:

- Very Effective
- Somewhat Effective
- Uncertain
- Not Very Effective
- Not At All Effective
- N/A/No Answer

The personnel that supply information technology (IT) services for our organization are very capable in interpreting business problems and developing appropriate technical solutions.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree
- N/A/No Answer

When interrelating our actions to each other to meet changing conditions, we are:

- Very Effective
- Somewhat Effective
- Uncertain

○ Not Very Effective ○ Not At All Effective ○ N/A/No Answer

When we engage in re-deployment to better match changes in demand, we are:

○ Very Effective ○ Somewhat Effective ○ Uncertain

○ Not Very Effective ○ Not At All Effective ○ N/A/No Answer

When ensuring that there is compatibility between group members expertise and work processes, we are:

○ Very Effective ○ Somewhat Effective ○ Uncertain

○ Not Very Effective ○ Not At All Effective ○ N/A/No Answer

The personnel that supply information technology (IT) services for our organization are very knowledgeable about the business environment.

○ Strongly Agree ○ Agree ○ Neutral ○ Disagree

○ Strongly Disagree ○ N/A/No Answer

As compared to other paramedic services, what is the level of your services' overall service innovation performance in the past 3 years?

Very High High Medium Low Very Low

N/A/No Answer

Our abilities for developing new knowledge that has the potential to influence service delivery are:

Very Effective Somewhat Effective Uncertain

Not Very Effective Not At All Effective N/A/No Answer

When finding time for implementing ideas for new service delivery models and improving our existing service delivery models, we are:

Very Effective Somewhat Effective Uncertain

Not Very Effective Not At All Effective N/A/No Answer

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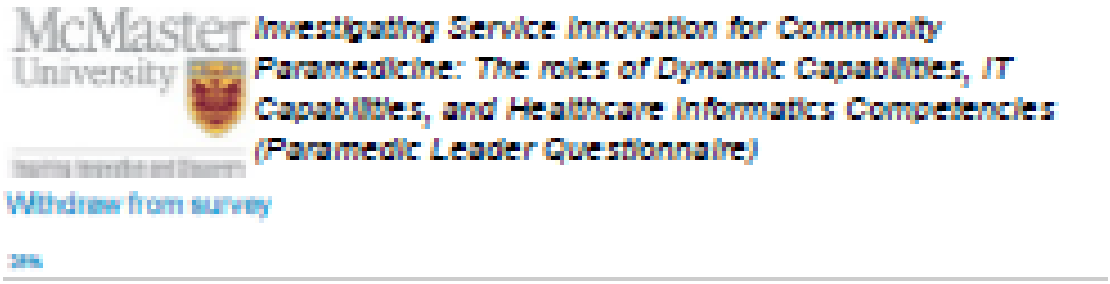
Layout Page 2



In the last three years, have you attempted to implement any changes in how you deliver your services, for the purpose of improving a specific, measured outcome?

Yes No

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Layout Page 3

Investigating Service Innovation for Community Paramedicine: The roles of Dynamic Capabilities, IT Capabilities, and Healthcare Informatics Competencies (Paramedic Leader Questionnaire)

Withdraw from survey

42%

In the last three years, have any of the changes you have made resulted in the improvement of an outcome that you intended to improve?

◯ Yes ◯ No

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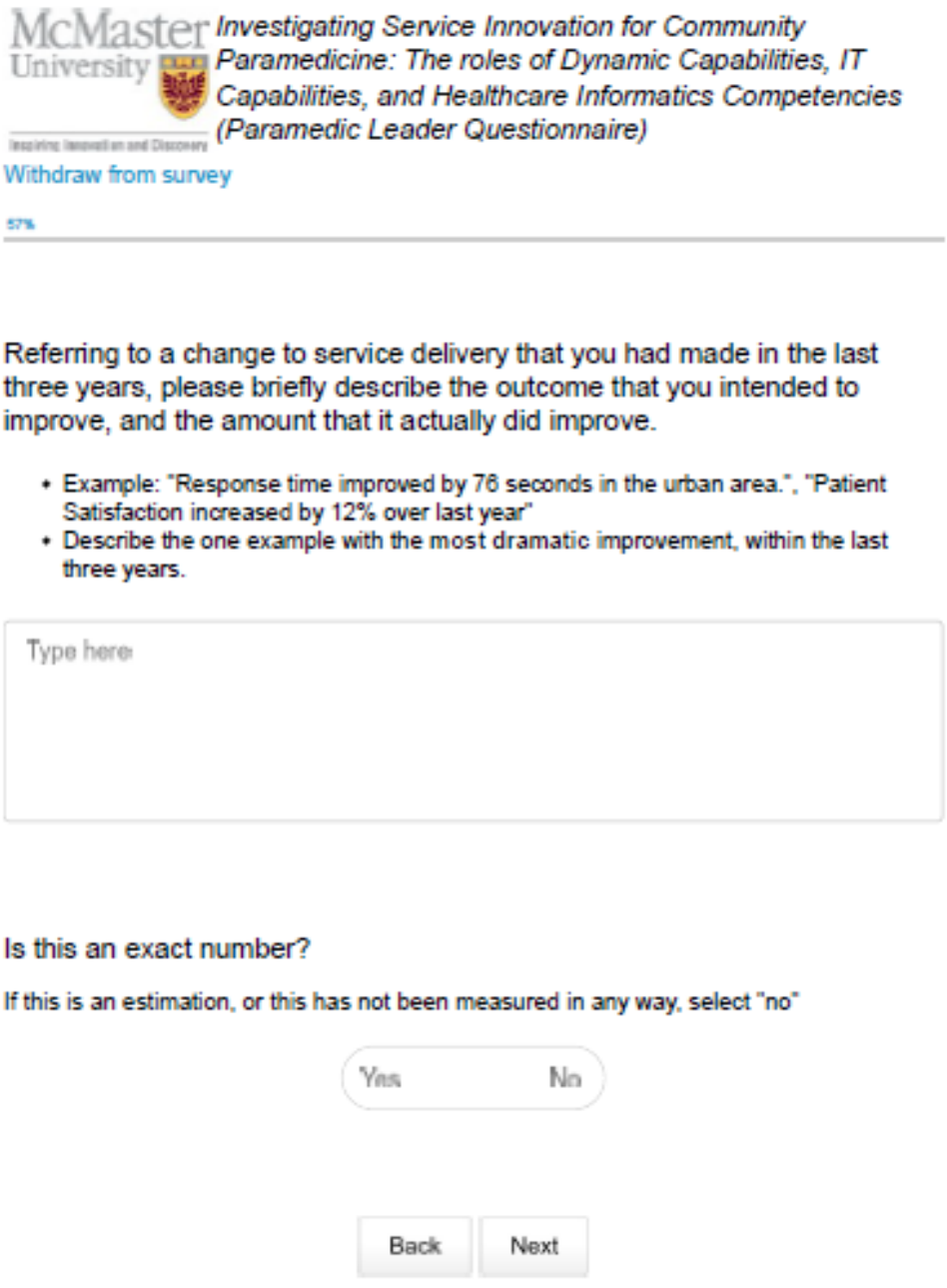

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Investigating Service Innovation for Community Paramedicine: The roles of Dynamic Capabilities, IT Capabilities, and Healthcare Informatics Competencies (Paramedic Leader Questionnaire)

Withdraw from survey

Your Title

Examples: Chief of EMS, Deputy Chief of EMS, Zone Executive Director

Type here

Your Rank

Examples: PCP, ACP

Type here

Your Gender

- Male
- Female
- Prefer Not to Answer

Years in position:

Enter a number:

Type here

Please Enter the Name of your Service

Type here

Province/Territory

Overseeing Body

# of Active Paramedics (by classification)

Example: 15 ACPs, 70 PCPs, etc.

Type here

# of Dedicated CP Personnel

Integer, must be Zero or Greater

Type here

# of Personnel that partially conduct CP activities

Integer, must be Zero or Greater

Type here

Back Next

Reminder

These questions are optional. It is not necessary to search for this information if it is not readily on hand.

# of total staffing hours (annual, 2013)

Integer, At Least Zero

Type here

# of staffing hours dedicated to CP (annual, 2013)

Type here

% Rural by Call Volume (emergency)

Type here

% Rural by Area served (geographical)

Type here

Years offering CP services

For portions of year, use decimal numbers. If you don't offer any CP services, enter "0"

Type here

$ Funding for CP services (2013)

Type here

$ Funding for IT Training (2013)

Type here

$ Funding for Technology (2013)

Software, Servers, Laptops, Devices, etc

Type here

List the types of CP services you currently provide

Example: Home visits for the elderly, Chronic Disease education, etc

Type here

Back Submit

Layout Finish Page

Investigating Service Innovation for Community Paramedicine: The roles of Dynamic Capabilities, IT Capabilities, and Healthcare Informatics Competencies (Paramedic Leader Questionnaire)

Thank you for taking the time to complete this survey. The investigator will send you some material to assist your efforts to recruit paramedics.

Appendix D – McMaster University REB Documentation

Certificate https://ethics.mcmaster.ca/mreb/print_approval_b

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McMaster University Research Ethics Board (MREB)

c/o Research Office for Administrative Development and Support, MREB Secretariat, GH-305, e-mail: ethicsoffice@mcmaster.ca

CERTIFICATE OF ETHICS CLEARANCE TO INVOLVE HUMAN PARTICIPANTS IN RESEARCH

Application Status: New ☑ **Addendum** ☐ **Project Number:** 2014 216

TITLE OF RESEARCH PROJECT:

Investigating Service Innovation for Community Paramedicine: The roles of Dynamic Capabilities, IT Capabilities, and Healthcare Informatics Competencies

Faculty Investigator(s)/ Supervisor(s)	Dept./Address	Phone	E-Mail
J. Tan	Business	26166	tanjosep@mcmaster.ca
Student Investigator(s)	**Dept./Address**	**Phone**	**E-Mail**
M. Dohan	Business	807-630-44	dohanms@mcmaster.ca

The application in support of the above research project has been reviewed by the MREB to ensure compliance with the Tri-Council Policy Statement and the McMaster University Policies and Guidelines for Research Involving Human Participants. The following ethics certification is provided by the MREB:

☐ The application protocol is cleared as presented without questions or requests for modification.

☑ The application protocol is cleared as revised without questions or requests for modification.

☐ The application protocol is cleared subject to clarification and/or modification as appended or identified below:

COMMENTS AND CONDITIONS: Ongoing clearance is contingent on completing the annual completed/status report. A "Change Request" or amendment must be made and cleared before any alterations are made to the research.

Reporting Frequency:	Annual: Nov-18-201	Other:

Date: Nov-18-2014 **Chair, Dr. B. Detlor**

McMaster University
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McMaster University Research Ethics Board (MREB)

c/o Research Office for Administrative Development and Support, MREB Secretariat, GH-305, e-mail: ethicsoffice@mcmaster.ca

CERTIFICATE OF ETHICS CLEARANCE TO INVOLVE HUMAN PARTICIPANTS IN RESEARCH

Application Status: New ☐ **Addendum** ☑ **Project Number:** 2014 216

TITLE OF RESEARCH PROJECT:

Investigating Service Innovation for Community Paramedicine: The roles of Dynamic Capabilities, IT Capabilities, and Healthcare Informatics Competencies

Faculty Investigator(s)/ Supervisor(s)	Dept./Address	Phone	E-Mail
J. Tan	Business	26166	tanjosep@mcmaster.ca
Student Investigator(s)	**Dept./Address**	**Phone**	**E-Mail**
M. Dohan	Business	807-630-44	dohanms@mcmaster.ca

The application in support of the above research project has been reviewed by the MREB to ensure compliance with the Tri-Council Policy Statement and the McMaster University Policies and Guidelines for Research Involving Human Participants. The following ethics certification is provided by the MREB:

☑ The application protocol is cleared as presented without questions or requests for modification.

☐ The application protocol is cleared as revised without questions or requests for modification.

☐ The application protocol is cleared subject to clarification and/or modification as appended or identified below:

COMMENTS AND CONDITIONS: Ongoing clearance is contingent on completing the annual completed/status report. A "Change Request" or amendment must be made and cleared before any alterations are made to the research.

Amendment#1, cleared Feb. 5, 2015

Reporting Frequency:	Annual: Nov-18-2015	Other:

Date: Nov-18-2014 **Chair, Dr. B. Detlor**

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McMaster University Research Ethics Board (MREB)

c/o Research Office for Administrative Development and Support, MREB Secretariat, GH-305, e-mail: ethicsoffice@mcmaster.ca

CERTIFICATE OF ETHICS CLEARANCE TO INVOLVE HUMAN PARTICIPANTS IN RESEARCH

Application Status: New ☐ **Addendum** ☑ **Project Number:** 2014 216

TITLE OF RESEARCH PROJECT:

Investigating Service Innovation for Community Paramedicine: The roles of Dynamic Capabilities, IT Capabilities, and Healthcare Informatics Competencies

Faculty Investigator(s)/ Supervisor(s)	Dept./Address	Phone	E-Mail
J. Tan	Business	26166	tanjosep@mcmaster.ca
Student Investigator(s)	**Dept./Address**	**Phone**	**E-Mail**
M. Dohan	Business	807-630-4426	dohanms@mcmaster.ca

The application in support of the above research project has been reviewed by the MREB to ensure compliance with the Tri-Council Policy Statement and the McMaster University Policies and Guidelines for Research Involving Human Participants. The following ethics certification is provided by the MREB:

- ☑ The application protocol is cleared as presented without questions or requests for modification.
- ☐ The application protocol is cleared as revised without questions or requests for modification.
- ☐ The application protocol is cleared subject to clarification and/or modification as appended or identified below:

COMMENTS AND CONDITIONS: Ongoing clearance is contingent on completing the annual completed/status report. A "Change Request" or amendment must be made and cleared before any alterations are made to the research.

Amendment#2, cleared August 17, 2015

Reporting Frequency:	Annual: Nov-18-2015	Other:

Date: Nov-18-2014 **Chair, Dr. D. Young**

Appendix E – AHS Research Agreement

RESEARCH AGREEMENT

BETWEEN: **AND**

Michael Dohan McMaster University - RB-1038, 1280 Main Street West Hamilton, ON L8S 4M4 Phone: 807-630-4426 Email: dohanms@mcmaster.ca **(The "RESEARCHER")**	**Alberta Health Services** Mary Ann Podgorski 4500 – 16 Avenue NW Calgary, AB T3B 0M6 Phone: 403-944-5596 Email: MaryAnn.Podgorski@ahs.ca **("AHS")**
MREB Study Number: 2014 216	

WHEREAS:

1. The RESEARCHER has requested the participation of AHS employees by sending survey to paramedics in Alberta as part of a research study regarding: Investigating Service Innovation for Community Paramedicine: The roles of Dynamic Capabilities, IT Capabilities, and Healthcare Informatics Competencies as described in Schedule "A";
2. AHS has considered the participation of AHS employees in the Research Study;
3. The parties wish to enter into an agreement to govern use of information arising from the participation of AHS employees in the Research Study;

THEREFORE, in consideration of the above, the covenants contained herein and other good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, each of the parties covenants and agrees with the other, as follows:

1. AHS shall allow the RESEARCHER to seek the participation of AHS employees in the Research Study in accordance with Schedule "A";
2. The RESEARCHER may use and disclose the information arising from the participation of AHS employees in the Research Study only for the purposes of the above named Research Study as described in Schedule "A";
3. The RESEARCHER shall not use or further disclose the information arising from the participation of AHS employees in the Research Study except as permitted or required by this Agreement and REB approved ethics submission;

Alberta Health Services

4. The RESEARCHER shall not disclose to AHS personally identifying information regarding or arising from the participation or non-participation of AHS employees in the Research Study, except as required by law; The RESEARCHER shall not include any personally identifying information of AHS employees, patients or other individuals associated with AHS in any publication or presentation;

5. The RESEARCHER shall use appropriate safeguards to keep information arising from the participation of AHS employees in the Research Study secure and shall report to the AHS any unauthorized use or disclosure of which the RESEARCHER becomes aware, or of any breach of this Agreement by the RESEARCHER and cooperate with any AHS investigation of any such breach; and

6. The RESEARCHER shall ensure that any agent, contractor, partner, or any other individual or organization, that will have access to information arising from the participation of AHS employees in the Research Study, agrees to be bound by the same restrictions, terms and conditions that apply to the RESEARCHER pursuant to the Agreement.

By my signature hereunder, I AGREE to be bound by the terms and conditions herein effective as of date of execution.

Researcher (Principal Investigator)

Michael Dohan
Name

Signature

21-Dec-2015
Date

Alberta Health Services

Name	Title	Date	Signature
Mary Ann Podgorski	**Research Administration Advisor**		

This Agreement may be signed in counterparts, and each counterpart may be delivered by facsimile or signed PDF by email. Each counterpart shall constitute an original, and when taken together, shall constitute one and the same instrument.

Alberta Health Services

4. The RESEARCHER shall not disclose to AHS personally identifying information regarding or arising from the participation or non-participation of AHS employees in the Research Study, except as required by law; The RESEARCHER shall not include any personally identifying information of AHS employees, patients or other individuals associated with AHS in any publication or presentation;

5. The RESEARCHER shall use appropriate safeguards to keep information arising from the participation of AHS employees in the Research Study secure and shall report to the AHS any unauthorized use or disclosure of which the RESEARCHER becomes aware, or of any breach of this Agreement by the RESEARCHER and cooperate with any AHS investigation of any such breach; and

6. The RESEARCHER shall ensure that any agent, contractor, partner, or any other individual or organization, that will have access to information arising from the participation of AHS employees in the Research Study, agrees to be bound by the same restrictions, terms and conditions that apply to the RESEARCHER pursuant to the Agreement.

By my signature hereunder, I AGREE to be bound by the terms and conditions herein effective as of date of execution.

Researcher (Principal Investigator)

Michael Dohan
Name

Signature

Date

Alberta Health Services

Name	Title	Date	Signature
Mary Ann Podgorski	**Research Administration Advisor**		Mary-Ann Podgorski 2015.12.22 08:41:25 -07'00'

This Agreement may be signed in counterparts, and each counterpart may be [illegible] PDF by email. Each counterpart shall constitute an original, and when taken together, shall co[illegible] same instrument.

Alberta Health Services

SCHEDULE A

A copy of the Researcher's Proposal and Ethics Board Approvals along with any amendments or renewals and a list of data elements such as survey questions, interview guides or templates.

See attached for the Study Protocol:

- Investigating Service Innovation for Community Paramedicine: The roles of Dynamic Capabilities, IT Capabilities, and Healthcare Informatics Competencies Document title (2015Aug10 Dohan Application, 2015Aug10 Dohan Ethics Amendment Application)

See attached for the Ethics Board approvals, amendments and renewals:

- 2015Nov18 Dohan Ethics Approval
- 2015Aug17 Dohan Ethics Amendment

See attached for the Case Report form, survey questions or interview guide:

Consent will be obtained online at the study website.

- Appendix_13I_Paramedic_Leader_Letter_of_Information
- Appendix_13E_Paramedic_Letter_of_Information
- Appendix_13C_Paramedic_Leader_Questionnaire
- Appendix_13F_Paramedic_Questionnaire
- Appendix_13J_Paramedic_Questionnaire_Print
- Appendix_13D_Paramedic_Leader_Demographic_Questionnaire_Items
- Appendix_13G_Paramedic_Demographic_Questionnaire_Items
- Appendix_13B_Paramedic_Leader_Manipulation_Check
- Appendix_12C_Paramedic_Poster

Description of the process for AHS employee recruitment and participation:

This research will take place in 2 steps. The first step involves recruiting one zone executive director per zone to fill out an online survey. Directors will respond to an email sent with assistance of AHS (with up to 2 follow ups). The survey will take approximately 30-40 minutes to complete and directors will be able to complete it at any time convenient for them.

The second step involves the participating Directors sending an email invitation to participate to paramedics at their respective zones, with links to the online survey (with up to 2 follow ups). The survey will take approximately 15-20 min to complete and paramedics will be able to complete it at any time convenient for them.

Appendix F – Southern Health (MB) Ethics Approval

SOUTHERN HEALTH-SANTÉ SUD
Southport Regional Office
180 Centennaire Drive
Southport MB R0H 1N1
T 204-428-2720 | F 204-428-2779
www.southernhealth.ca

8 September 2015

Michael Dohan, MSc
PhD Candidate in Business Administration
DeGroote School of Business, McMaster University
dohanms@mcmaster.ca

Dear Mr. Dohan,

Thank you for your request to conduct research in Southern Health-Santé Sud. Your research proposal titled **Investigating Service Innovation for Community Paramedicine: The roles of Dynamic Capabilities, IT Capabilities, and Healthcare Informatics Competencies** has been reviewed by Southern Health-Santé Sud.

After careful consideration it has been determined that your proposal meets the requirements to conduct research in our region until your Research Ethics Board (REB) approval expires November 18, 2015 provided that references to the draw for a gift worth $500 be removed from all correspondence to participants/staff (i.e. flyers/advertising, participant information, emails, etc.) as this could be interpreted as a personal benefit to staff when they are completing the survey while working for the region.

Should you wish to continue your research beyond the REB expiry date of November 18, 2015, please submit your updated REB approval to researchapproval@southernhealth.ca one month prior to the expiry date.

Your Southern Health-Santé Sud contact is:

NAME:	Scott Noble	POSITION:	Regional Director EMS
PHONE:	(204) 346-7028	EMAIL:	snoble@southernhealth.ca

The region is interested in reviewing the results of your research study and would appreciate a copy of the results sent to Kristine Hannah, Regional Director Quality, Patient Safety & Risk at khannah@southernhealth.ca.

On behalf of Southern Health-Santé Sud, thank you for your interest in conducting research in the region.

Kindest regards,

K Hannah

Kristine Hannah
Regional Director Quality, Patient Safety & Risk

cc Scott Noble, Regional Director EMS
Cheryl Harrison, Executive Director-Mid

Appendix G – Paramedic Leader Second Phase Interview and Recruitment Material

McMaster University
Inspiring Innovation and Discovery

Investigating Service Innovation for Community Paramedicine: The roles of Dynamic Capabilities, IT Capabilities, and Healthcare Informatics Competencies

Faculty Supervisor
Dr. Joseph Tan
DeGroote School of Business
McMaster University
Hamilton, Ontario, Canada
(905) 525-9140 ext. 26166
E-mail: tanjosep@mcmaster.ca

Principal Investigator:
Mr. Michael Dohan, (PhD Student)
DeGroote School of Business
McMaster University
Hamilton, Ontario, Canada
(807) 630 4426
E-mail: dohanms@mcmaster.ca

Purpose of the Study

The purpose of the survey is to investigate how the ability of a paramedic service to exploit technology impacts the ability to develop innovative service delivery models. This research is being conducted as part of Mr. Dohan's doctoral dissertation for his PhD in Business Administration.

Procedures involved in the Research

As you had participated in a previous phase of this study, we invite you to contribute further by participating in a telephone interview, where your answers can be elaborated on. Interviews will take approximately 60 minutes.

We will ask questions, such as:

a. In what ways do paramedics with higher skills in using technology contribute to the innovativeness of the organization?
b. What processes at your organization encourage and support innovation?
c. What role does technology play in your organization in the future?

With your permission, the interview will be recorded. You will be asked this at the beginning the call.

Are there any risks to doing this study?

The risks involved in participating in this study are minimal.

There may be a psychological impact from this interview. You may feel uncomfortable or frustrated when discussing any shortcomings in your organization, with respect to its ability to innovate or achieve a high performance.

There may be a social impact if a breach of privacy occurs. You may worry about how others will react to what you say if a privacy breach were to occur, and find out if you said something critical about your organization.

You do not need to answer questions that you do not want to answer or that make you feel uncomfortable. I describe below the steps I am taking to protect your privacy.

When the results are published, you nor any other individual will be identified in the results.

Are there any benefits to doing this study?

The research itself will not benefit you directly. We hope to learn more about how paramedics can contribute to organizational activities related to developing and implementing innovative service delivery models. This could help determine an important driver of performance improvement and improving the well-being of the citizens you serve.

Payment or Reimbursement

There is no payment or reimbursement offered for participating in this study.

Who will know what I said or did in the study?

You are participating in this study confidentially. I will not use your name or any information that would allow you to be identified. No one but Mr. Dohan and Dr. Tan will know whether you were in the study unless you choose to tell them.

Care will be taken to minimize the necessity to document and record any identifying data during and after the interview.

Your answers will be kept offline in a secure cabinet where only the Mr. Dohan and Dr. Tan will have access to this data, and the data will be treated with the utmost care.

If a breach does occur, retrieving and re-securing the data will be an urgent priority for the researchers. As well, the security venerability is addressed. As well, the REB will be notified if this event is to happen.

It is a concern that, when the final report is written, it may identify specific paramedic services or regions who are low performers, and this may have a detrimental effect in the paramedic community and elsewhere. In order to mitigate this, no single paramedic will be identified when the results are published. If necessary, your data will be aggregated with others when published in order to conceal your identity.

Once the study is complete, an archive of the data, without identifying information, will be kept offline in a secure location on McMaster University campus for 10 years, where only the researchers will have access to it. After this period it will be destroyed.

What if I change my mind about being in the study?

Your participation in this study is voluntary. It is your choice to be part of the study or not. If you decide to be part of the study, you can stop (withdraw), from the interview for whatever reason, even after signing the consent form, part-way through the telephone interview, or up until approximately May 2016, when I plan to submit my final dissertation.

If you decide to withdraw, there will be no consequences to you. In cases of withdrawal, any data you have provided will be destroyed unless you indicate otherwise. If you do not want to answer some of the questions you do not have to, but you can still be in the study.

How do I find out what was learned in this study?

I expect to have this study completed by approximately June of 2016. A summary of the results will be posted at http://www.emsstudy.com. If you would like to receive the summary personally, please let me know how you would like me to send it to you. You may already have indicated this in the previous phase.

Questions about the Study

If you have questions or need more information about the study itself, please contact me by email at dohanms@mcmaster.ca.

This study has been reviewed by the McMaster University Research Ethics Board and received ethics clearance. If you have concerns or questions about your rights as a participant or about the way the study is conducted, please contact:

McMaster Research Ethics Secretariat
Telephone: (905) 525-9140 ext. 23142
C/o Research Office for Administrative Development and Support
E-mail: ethicsoffice@mcmaster.ca

If you wish to participate, please send an email to the verify the following:

- ✓ I am a paramedic leader currently overseeing day-to-day operations at a Canadian paramedic service.

- ✓ I have read the information presented in the information letter about a study being conducted by Joseph Tan and Michael S. Dohan of DeGroote School of Business, McMaster University.
- ✓ I have had the opportunity to ask questions about my involvement in this study. I have had the opportunity to receive additional details I requested.
- ✓ I acknowledge that this study involves an approximately 60 minute phone interview, and it will be recorded only with my consent.
- ✓ I understand that if I agree to participate in this study, I can withdraw up until approximately May 2016, when I plan to submit my dissertation. Any data that I have submitted up until this point will be destroyed unless I indicate otherwise.
- ✓ I have been provided a copy of this form.
- ✓ I agree to participate in the study.

Interview Guide

1. Innovation: Current Use of Technology
    a. How does the use of innovative technology help your organization to improve its services? (probe: what is it used for? Who is it used by? what tech is used?)
2. Innovation: Current Measurement and Assessment of Metrics
    a. What performance metrics are you currently tracking, and how is the technology you use assist you in the tracking and utilization of these metrics? (probe: monitoring and controlling, communication/coordination with int/ext entities, mandatory vs optional metrics)
3. Innovation: Processes around innovation
    a. What processes at your organization encourage and support innovation? (probe: how are specific people involved, external collaboration, how is technology involved)
4. Competencies: Contribution of Skills
    a. Do you see technology skills as an important for paramedics to have? (yes or no, very/modestly, probe: please explain)
    b. In what ways do paramedics with higher skills in using technology contribute to the innovativeness of the organization?
    c. In what ways do paramedics with lower technology skills hinder innovation at your organization?
5. Barriers to Innovation
    a. What are barriers to innovation at your organization (probe: internal vs external, related to skills of paramedics, related to technology)
6. The future
    a. What role does technology play in your organization in the future?
    b. How do you see the role of technology impacting the paramedics job in the future?
7. Open
    a. Regarding the use of technology in paramedicine, as well as how innovation occurs in paramedicine, do you have anything to add? (probe: did we miss anything)

Appendix H – McMaster University REB Documentation for Second Phase

McMaster University
Inspiring Innovation and Discovery

McMaster University Research Ethics Board (MREB)

c/o Research Office for Administrative Development and Support, MREB Secretariat, GH-305, e-mail: ethicsoffice@mcmaster.ca

CERTIFICATE OF ETHICS CLEARANCE TO INVOLVE HUMAN PARTICIPANTS IN RESEARCH

Application Status: New ☐ **Addendum** ☑ **Project Number:** 2014 216

TITLE OF RESEARCH PROJECT:

Investigating Service Innovation for Community Paramedicine: The roles of Dynamic Capabilities, IT Capabilities, and Healthcare Informatics Competencies

Faculty Investigator(s)/ Supervisor(s)	Dept./Address	Phone	E-Mail
J. Tan	Business	26166	tanjosep@mcmaster.ca
Student Investigator(s)	**Dept./Address**	**Phone**	**E-Mail**
M. Dohan	Business	807-630-44[illegible]	dohanms@mcmaster.ca

The application in support of the above research project has been reviewed by the MREB to ensure compliance with the Tri-Council Policy Statement and the McMaster University Policies and Guidelines for Research Involving Human Participants. The following ethics certification is provided by the MREB:

- ☐ The application protocol is cleared as presented without questions or requests for modification.
- ☑ The application protocol is cleared as revised without questions or requests for modification.
- ☐ The application protocol is cleared subject to clarification and/or modification as appended or identified below:

COMMENTS AND CONDITIONS: Ongoing clearance is contingent on completing the annual completed/status report. A "Change Request" or amendment must be made and cleared before any alterations are made to the research.

Amendment#3: cleared January 18, 2016

Reporting Frequency:	Annual: Nov-18-2016	Other:

Date: Nov-18-2014 **Chair, Dr. D. Young**

Appendix I – Support Letter from OAPC

SUPERIOR NORTH EMS
www.SuperiorNorthEMS.com

HEADQUARTERS – *Chief of EMS*

24 October 2014

TO WHOM IT MAY CONCERN

RE: SUPPORT LETTER FOR PROJECT: Investigating Service Innovation for Community Paramedicine: The roles of Dynamic Capabilities, IT Capabilities, and Healthcare Informatics Competencies

This letter is to affirm my support for the research project, titled "Investigating Service Innovation for Community Paramedicine: The roles of Dynamic Capabilities, IT Capabilities, and Healthcare Informatics Competencies", conducted by Michael S. Dohan, PhD Candidate at McMaster University's DeGroote School of Business.

As President of the Ontario Association of Paramedic Chiefs (OAPC), I believe that this research is important, timely, and essential in facilitating the implementation of Community Paramedicine activities in Ontario and Canada, contributing to reducing unnecessary usage of emergency healthcare resources.

Mr. Dohan and his team are addressing a real and serious problem with this research, within an already-established and ongoing relationship with the OAPC and Superior North Emergency Medical Service (SNEMS).

I will see to it that he will have access to other Chiefs of EMS and paramedics in Ontario as needed for this project. If you have any questions, please feel free to contact me at ngale@thunderbay.ca or (807) 625-3259.

Sincerely,

Norm Gale (CMM III, MBA)
President, Ontario Association of Paramedic Chiefs
Chief of EMS, Superior North EMS

Proudly Serving the People of the District of Thunder Bay

105 S. Junot Ave., Thunder Bay ON P7B 4X6
Tel: (807) 625-3259 Fax: (807) 684-2657

Appendix J – Paramedic Leader Item Loadings and Cross-Loadings

	sense	learn	integr	coord	dc	sip	recon	iation	relinf	itbusexp	TAC	IPC	UWT
sense1	-0.824	0.402	0.512	0.474	0.694	0.396	0.548	0.569	0.067	0.175	-0.013	0.377	0.244
sense2	-0.875	0.625	0.662	0.572	0.817	0.653	0.579	0.59	0.175	0.158	0.063	0.093	-0.008
sense3	-0.837	0.421	0.596	0.525	0.693	0.564	0.625	0.48	0.158	0.335	-0.04	0.414	0.078
sense4	-0.818	0.534	0.626	0.467	0.746	0.692	0.492	0.623	0.032	0.101	-0.019	0.114	0.04
learn1	0.55	-0.613	0.596	0.262	0.576	0.57	0.337	0.336	-0.089	-0.102	0.254	-0.071	-0.147
learn2	0.22	-0.714	0.524	0.401	0.482	0.411	0.015	0.413	0.302	0.384	0.182	0.085	-0.173
learn3	0.154	-0.674	0.4	0.363	0.381	0.329	0.073	0.262	0.207	0.352	0.239	-0.089	-0.003
learn4	0.426	-0.509	0.459	0.286	0.55	0.619	0.347	0.403	0.164	0.243	-0.203	0.11	-0.201
learn5	0.645	-0.816	0.684	0.514	0.833	0.574	0.525	0.603	0.286	0.278	0.102	0.149	-0.067
integr1	0.458	0.661	-0.663	0.322	0.648	0.715	0.359	0.592	0.247	0.262	-0.006	0.095	-0.176
integr2	0.275	0.204	-0.433	0.41	0.313	0.202	0.47	0.133	0.035	0.064	-0.128	0.043	-0.186
integr3	0.518	0.454	-0.73	0.48	0.538	0.312	0.43	0.465	0.078	0.193	0.156	0.241	0.182
integr4	0.751	0.678	-0.838	0.604	0.849	0.616	0.518	0.448	0.121	0.15	0.058	0.312	0.212
integr5	0.405	0.67	-0.751	0.404	0.657	0.403	0.27	0.325	0.164	0.148	0.154	0.116	-0.155
coord1	0.385	0.392	0.38	-0.725	0.483	0.124	0.202	0.387	0.413	0.385	-0.052	0.12	0.143
coord2	0.601	0.55	0.53	-0.532	0.718	0.443	0.529	0.51	0.267	0.248	0.128	0.287	-0.043
coord3	0.391	0.375	0.462	-0.73	0.52	0.214	0.433	0.416	0.128	0.365	0.046	0.2	0.231
coord4	0.432	0.137	0.345	-0.666	0.355	0.189	0.599	0.203	0.122	0.186	0.067	0.022	0.185
coord5	0.308	0.46	0.474	-0.705	0.445	0.201	0.338	0.28	0.617	0.629	0.084	-0.012	0.083
sip1	0.573	0.753	0.568	0.315	0.675	-0.893	0.26	0.607	0.168	0.205	0.014	-0.113	-0.171
sip2	0.675	0.582	0.599	0.298	0.691	-0.883	0.477	0.485	0.077	0.116	-0.097	-0.091	-0.02
sip3	0.552	0.571	0.504	0.215	0.573	-0.897	0.333	0.489	0.018	0.046	-0.178	-0.122	-0.35
sip4	0.635	0.667	0.678	0.335	0.706	-0.862	0.531	0.579	0.088	0.17	-0.048	0.022	-0.228
recon1	0.616	0.3	0.522	0.383	0.517	0.395	-0.86	0.342	0.013	0.066	0.008	0.1	0.234
recon2	0.535	0.361	0.465	0.657	0.591	0.38	-0.86	0.43	0.201	0.201	-0.161	0.076	0.122
iation1	0.424	0.462	0.467	0.272	0.462	0.534	0.209	-0.657	0.071	0.129	-0.026	0.038	-0.244
iation2	0.633	0.581	0.563	0.492	0.707	0.579	0.447	-0.835	0.246	0.38	-0.079	0.177	-0.064
iation3	0.462	0.49	0.383	0.277	0.485	0.485	0.224	-0.866	0.143	0.231	-0.14	-0.023	-0.047
iation4	0.481	0.339	0.333	0.414	0.466	0.411	0.412	-0.729	0.176	0.201	-0.088	0.015	0.238
integration5	0.584	0.449	0.492	0.549	0.591	0.334	0.435	-0.733	0.216	0.316	0.037	0.269	0.024
relinf1	0.141	0.275	0.181	0.345	0.247	0.196	0.096	0.185	-0.805	0.708	0.087	0.194	-0.035
relinf2	0.238	0.302	0.172	0.341	0.291	0.163	0.152	0.309	-0.732	0.557	0	0.119	0.187
relinf3	0.189	0.27	0.188	0.333	0.282	0.227	0.192	0.368	-0.725	0.496	-0.119	0.035	-0.18
relinf4	-0.056	-0.018	0.003	0.405	0.006	-0.143	0.01	-0.033	-0.802	0.576	-0.074	0.006	0.094
relinf5	-0.035	0.198	0.176	0.272	0.115	-0.086	0.012	0.002	-0.628	0.412	-0.131	0.172	0.024
itbusexp1	0.026	0.23	0.048	0.35	0.096	0.098	-0.062	0.182	0.484	-0.809	0.261	0.11	0.048
itbusexp2	0.375	0.51	0.496	0.625	0.521	0.264	0.324	0.439	0.713	-0.893	0.143	0.324	0.034
itbusexp3	0.212	0.159	0.102	0.492	0.197	0.01	0.125	0.24	0.64	-0.89	0.164	0.15	0.277
itbusexp4	0.162	0.315	0.163	0.405	0.262	0.148	0.131	0.278	0.74	-0.858	0.083	0.106	0.046
TACscore	-0.002	0.189	0.09	0.074	0.06	-0.088	-0.089	-0.082	-0.057	0.186	-1	-0.027	0.099
IPCscore	0.296	0.059	0.25	0.172	0.254	-0.087	0.103	0.123	0.139	0.202	-0.027	-1	0.168
UWTscore	0.104	-0.164	-0.001	0.189	0.004	-0.218	0.207	-0.022	0.025	0.119	0.099	0.168	-1