Abstract
Emerging global health trends have compelled emergency management services (EMS) to proactively addressing non-emergency healthcare issues in the communities they serve. This reorientation towards addressing non-emergency issues may require paramedics to use information technology, such as electronic medical records or health information exchanges. As such, the level of competencies that paramedics have with using technology may impact the performance of the firm, and the healthcare system by extension. This article presents a theoretical model that integrates Healthcare Informatics Competencies into the Dynamic Capabilities and Resource Based View, providing a new skills and knowledge focus for the facilitation of technology adoption in healthcare.

1. Introduction

Inefficiencies in prehospital emergency care contribute to unavailability of these limited emergency services, and negatively impacts health and well-being of citizens, and front-line paramedics. Diversion of patients away from emergency services and towards lower resource healthcare providers such as home care and other social services can avoid future ambulance trips to the Emergency Department (ED). This problem is documented in various jurisdictions globally [9,22,59].

The Community Paramedicine (CP) service delivery model is being developed to address these problems [58] to provide a small amount of care before problems warrant an emergency visit to the ED. Although still in its formative and varied stages of implementation in its various Emergency Management Services (EMSs), the CP extends the role of currently what a paramedic would normally do by including non-emergency protocols as part of their duties. These include providing outreach to frequent users of emergency services [3], chronic disease patients, rural populations and the elderly. Initial evidence has demonstrated success with this role, with a 41% reduction in emergency department among frequent use patients in Hamilton, Ontario [7], and drastic reduction in repeat 911 calls in Toronto [69].

Considering that CPs will be working with many populations that frequently use and benefit from e-health and information technologies, it is inevitable that they will use these technologies for accessing and updating electronic medical records (EMRs), sharing data with other professionals, researching, learning, or adhering to security and privacy protocol. Technology adoption is a wide and diverse body of knowledge that has served researchers and designers well, as they seek to understand why people do, and do not, use technology [18,20,72,89]. Research on Healthcare Informatics Competencies (HICs) has produced many sets of competencies needed to measure the judge if occupants of job roles have adequate knowledge and skills in using healthcare technology, in a wide variety of roles. Despite that no known set of HICs are available for paramedics, these skills are identified as being important assets to paramedics, from the governing bodies that are defining CP, and how it will alter the role of the paramedic [24,28,61,63]. In other words, as these new roles are being defined, there is a lack of evidence that can be used to inform an important facet of these roles.

Further, as the implementation of CP becomes more widespread, there will be a need to shape the services and programs implemented to reflect the local environment that the CPs practice in. The Dynamic Capabilities (DC) approach, an extension of the Resource Based View (RBV) [55,90] which focuses on the capabilities of the organization to reconfigure resources to address changing forces in the environment [84,85], offers a suitable lens to view this problem through, for two reasons. First, the ability of a healthcare worker to adjust to a new system, appraise a system in relation to current and proposed tasks, and suggest improvements to processes is likely to have an impact on the ability of a firm to detect changes in the environment, plan resource reconfigurations, and deploy. Second, the ability of a firm to do this effectively will likely contribute to their performance.

This paper proposes a theoretical model integrating HICs in healthcare workers to the organization-level.
ability to dynamically reconfigure their resources, and produce performance benefits. The key contribution for this stream of research is the empirical linkage of individual competencies to organizational outcomes, as well as discovering characteristics of organizational processes that facilitate these linkages.

2. Background

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. Generally, emergency healthcare resources are overutilized [15,21,96], and many of these unnecessary visits to EDs involve the elderly [1] and those suffering from chronic diseases [8,82]. A new approach in EMS management is Community Paramedicine (CP), tasked with providing care to many types of patients, including the elderly, chronic disease patients, rural patients, and high-volume EMS users, with the intention of diverting them from emergency resources at a later date. This approach entails the deployment of paramedics for providing non-emergency care to frequent users of these services. Currently, there is little consensus as to what a community paramedic is or what CP entails, as many different jurisdictions are adapting the model to their own local context [6,12]. Further, there are several different terms to describe what appears to be the same role, such as extended care paramedic [62], paramedic practitioner [53] and others. There are however several dominant themes in the current state of the literature, which will be discussed below.

2.1 Healthcare Utilization Reduction

The intention of CP roles in an EMS service is to provide preventative and maintenance care in such a way that it will eliminate the future need for a trip to the ED in identified and targeted populations [28,41,88]. Some studies have reported early success in such initiatives, citing lower cost and higher satisfaction [51], reduced ED utilization [52] and reduced emergency call volume [95].

2.2 Local Adaptation

As each community is unique, so will the problems that the EMS services will address, whether through traditional or community programs. With this in mind, it is important that CP programs have some freedom to customize their offering, in line of what problems lead to increased healthcare utilization in the respective community. The EMS service in Toronto – a city with a large amount of skyscrapers and apartment buildings - offers a CP initiative to address falls from balconies and windows [87]. This can also be seen in the Australian context [6] as their state-run CP programs attempt to address needs respective to each state, with unique certification and training schemes.

A qualitative study took place after the implementation of a community paramedic in the largely rural County of Renfrew, Ontario, Canada. The program consists of key elements, including those focused on aging at home, conducting wellness clinics, and home visits. This program has evolved over time, as new needs emerged in the community [6,12].

2.3 Expanded Scope of Practice

The CP must be skilled in areas beyond other paramedics. These skills can be clinical, including phlebotomy, performing various tests and procedures, or non-clinical, including working with information technology, communication, co-ordinating care among several healthcare providers. In the program in Renfrew, Ontario [67], the skillsets these paramedics identified as important and differing from the ones they have already possessed were the ability to communicate with the patient before applying medical knowledge to them, building trust and long term relationships. Challenges that the paramedics faced when performing in a community role were having the skills to create long term relationships, education around determinants of health, and communicating to students the soft skills involved in conducting CP. Paramedics in Australia [66] identified communication with other healthcare workers and working with technology as a chief issue.

2.4 Healthcare Informatics Competencies

As many healthcare organizations are developing CP, the need to consider the use of technology by the paramedic has been expressed [24,28,61,63]. Facilitating the adoption of technology in healthcare organizations is a continuing endeavor, and has been the goal of much research. It has largely approached research in a way that originates from the perception of a technology by its intended users. This research includes technology acceptance [18,74], satisfaction and quality [20,43], and other user-centric perceptions and attitudes of technology that are borrowed largely from management-related areas of research. As technology will inevitably be replaced, altered, or integrated with other systems over time, the utility of this research is limited. The competency approach, one that is widely used in healthcare, presents an
alternative to the adoption stream of research. Whereas the former captures phenomena pertaining to the individual perceptions, attitudes, and level of satisfaction with a given technology at a point in time, and the latter focuses on skills, knowledge, and the ability of individuals to interact with many aspects of sociotechnical systems, and participate in change processes [80,81], for example.

The concept of competence originated from the idea that an organism needs a certain level of capacity to interact with its environment, obtained through a period of doing and learning [92]. The root of the concept is concerned with the way that humans have a natural motivation to explore novelties within their environments [92]. The concept was extended to the management world to refer to the ability of a worker to perform according to defined role requirements [54]. 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 [57]. The format and structure of competency models vary, 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 according to a theme. Competency models of these types can then be administered to the occupants of each role as a self-reported instrument, or by an observer, among other ways [57].

Healthcare has adopted the competency approach, applying it to educator [79], administrator [48], medical [42], and many other roles. Researchers have also focused on developing competency models for the use of technology in various roles. Generally referred to as healthcare informatics competencies (HICs), these models focus on the knowledge and skills necessary to be considered proficient at using the technology necessary in a defined role. It is considered a way to facilitate the adoption and effective use of technology in healthcare organizations [34,35,80,91]. Much of the research in the area has focused on developing instruments for self-evaluation in various disciplines such as nursing informatics [17,80]. 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, such as novice, expert, and so on [80].

Many researchers have focused on the development of HICs within practice, in current and future healthcare practitioners, managers and other actors [56]. As healthcare has many disciplines within it, there are informatics that focus on specific areas, such as the highly developed area of nursing informatics [32]. As CP is viewed as an application public health by paramedicine [38,60,64], [97] provides a relevant example, focusing on the HICs of public health professionals. The authors 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”. Three classifications of competencies are used. First, effective use of information includes skills related to analyzing data, basic research methods, and information retrieval and appraisal. Second, effective use of information technology 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 includes the ability to advocate for changes in technologies in the organization, participates in information technology projects, procures new technologies for the organization, and ensures the appropriateness of technologies according to the needs of the populace.

2.6 Gaps in HIC Research

A 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. This is so, 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 [54,57]. Indeed, very few studies relate HIC proficiency on any other variable, whether they be organization- or individual-level variables. Although this gap exists, several governing bodies seeking to adapt CP have identified the need for employees operating in this role to be able to use various technologies [24,28,61,63]. As healthcare in general has had difficulty adopting technology [49,73] and paramedics in particular have felt work related stress due to under-defined scopes of practice and roles [2,12], it is imperative that research on the use of technology within the context of CP 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 outcomes.
3. Theoretical Perspective

The RBV explains the performance of a firm as originating from the resources possessed 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 [90]. 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 [93], human [5,75] and organizational [86] resources [4]. The unique characteristics of these resources among firms are what allows for competitive advantage over existing, emerging and potential firms. After attempts to duplicate these resources have tried and failed, the resources are seen as a source of sustained competitive advantage [4]. Changes in the environment may render resources more or less relevant over time [27,85].

Dynamic Capabilities (DC) [85], an extension of the RBV, refers 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. These capabilities exist as sets of routines [94], and are distinct from operational capabilities. Whereas operational capabilities are used to complete the day-to-day business processing, DCs intend to change these operational capabilities when deemed necessary by changes occur in the environment, with technology, and so on [27,84,94]. In this stream, operational and dynamic capabilities have been referred to as zero-order and first-order capabilities, respectively [94]. Much of the research surrounding this topic has been from the interpretive approach, resulting in rich narrative of DCs, how they are developed, and other context-specific description (eg. [19,70,78]).

Despite debate surrounding the topic, several researchers maintain that dynamic capabilities exist as a set of “identifiable and specific routines” [27], and are indeed not ambiguous, tacit, or otherwise difficult to identify, although they are unique to each organization [29]. Building on the classification of capabilities proposed by Teece [84,85], Pavlou and El Sawy [71] propose a multilevel framework with the intent of pursuing quantitative research in the area of new product development (NPD). Firm performance, the distal outcome, is predicted by a framework that includes sensing, learning, integrating and coordinating capabilities. Sensing includes routines that are associated with identifying, interpreting and pursuing opportunities in the environment. Dimensions of sensing involves generating [30], disseminating [45] and responding [85] to intelligence. Learning capabilities include those that falter existing operational routines with new knowledge. Also referred to as absorptive capacity [99], they involve acquiring, assimilating, transforming, and exploiting knowledge [99]. Integrating capability entails combining knowledge from individuals into the operational capabilities. It involves contributing knowledge to the group level [68], representing individual and group knowledge [16], and interrelating knowledge within a system [31]. Coordinating capabilities refer to the ability to deploy resources and labor to new operational capabilities. They include assigning resources to tasks [36], appointing the right person to tasks [25], identifying synergies among tasks [26], and orchestrating activities [37].

3.2 Microfoundations

Microfoundations [85] refer to elements in a firm that contribute to capabilities. These may include knowledge, skills and other characteristics of the individual [33,85]. 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 [33,47,50,76,98]. Several case studies in healthcare have revealed substantial support for knowledge of the individual 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 [19], employee desire to change [77], and the ability to appraise new technologies against existing processes [78]. Overall, technology in the healthcare organization seems to facilitate DCs to make the organization more able to adapt to changing environmental forces. Despite this it takes human involvement in order for it 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.

4. Theoretical Development

Figure 1 (below) describes the theoretical model that will be evaluated in this research. As this study employs a multilevel model [46], the paramedics will be considered the individual level respondents, and paramedic leaders will be considered group-level respondents. Regarding emergence of individual level constructs to the group level, group level constructs will be classified as shared, direct-consensus constructs [10] (See the Discussion and Conclusion for
elaboration on this point). More details regarding the propositions in this model follows.

### 4.1 Impact on Organizational Outcomes

The first proposition refers to the ability of the capabilities of the organization to impact firm performance. This proposition, based on a key hypothesis in the RBV and DC literature [27,84,90], has been supported in diverse contexts, including new product development [71], green product development [11], and others. Further to this is the notion that DCs will impact performance, albeit mediated by operational capabilities. The logic is that a static operational capability, even if it is high-quality, will not contribute to performance gains in the long run, as the environment will change, leaving the operational capabilities obsolete. The outcome of processes associated with DCs are indeed organizational capabilities, and their quality will be judged by the capability of their outcomes.

**P1**: The impact of Dynamic Capabilities on Performance is mediated by Operational Capabilities.

### 4.2 Environmental Turbulence

Environmental turbulence refers to the frequency and amplitude at which changes happen in the context in which the organization operates [23]. This can be decomposed into market turbulence, referring to the volatility of demand, and technological turbulence, referring to the demand to pressure to change exerted by technological innovation [11]. Whereas both of these forces are theorized to affect healthcare processes [83], and the importance of adapting these types of programs to unique local conditions are important for healthcare initiatives such as CP [6,12,87], this factor is likely to affect the need for a healthcare organization to be dynamic. A turbulent environment will create the need to reconfigure [40,71], and thereby develop the capabilities necessary to both change and operate successfully in such an environment [85].

**P2**: Environmental Turbulence will amplify the influence of DCs on Operational Capabilities.

### 4.3 Effective Use of Information

As discussed above, the DC related to sensing includes routines pertaining to surveying the environment for opportunities [85]. In CP, this can entail seeking for better technologies, potential areas for CP application, and new health threats to the population. Further, learning entails the development of knowledge as to how organizational resources can be configured to address the opportunity [71]. Both detecting environmental phenomena and ways it can be addressed will entail effective research and reporting abilities. The Effective Use of Information classification of competencies [65] captures the level of proficiency related to seeking and appraising information, basic research skills, and so on. It is believed that organizations where staff have an ability to perform these activities will contribute to more effective sensing and learning processes. Therefore:

**P3a-b**: Group-Level Effective Use of Information will positively impact a) Sensing and b) Learning DCs.

### 4.4 Effective Use of Information Technology

Learning and Integrating Capabilities imply that some sort of change to operational capabilities is being planned or executed [71]. As previously discussed, Effective Use of Information Technology class of competencies [65] captures the proficiencies related to
the ability to use various technologies and applications, among others. Current evidence related to dynamic capabilities in healthcare credits the individual’s ability to appraise technology against current workflow in improving process outcomes [19,39,78], implying that individual knowledge of technology is necessary for process improvement with technological interventions. Therefore:

\[ P4a-c: \text{Group-Level Effective Use of Information Technology will positively impact a) Sensing, b) Learning and c) Integrating DCs.} \]

As the employee is likely to have access to some group of technologies that they use on the job, such as an electronic ambulance call report (eACR) as well as internet and email, they are likely to appraise these current technological resources against current processes, emerging problems, or potential projects [19,39,78]. Therefore it is likely that the satisfaction [20] that these users have with the current set of tools will influence the dynamic capabilities of the organization as well. It is theorized that satisfaction will amplify the relationship between Effective Use of Information Technology. Staff that is highly competent in using information technology will be more proficient in using the technology they have, yet if they use a technology that they are not satisfied with, this amounts to providing a worker with a substandard tool that they are forced to satisfice with. Therefore:

\[ P5a-c: \text{The impact of Group-Level Effective Use of Technology on a) Sensing, b) Learning and c) Integrating DCs will be amplified by Group-Level User Satisfaction of all technologies available.} \]

### 4.5 Effective Management of Information Technology Projects

The Employee Management in Information Technology Projects classification of competencies [65] focuses beyond using technology to improve one’s own performance, to improving the greater contribution of information technology to the performance of the organization. Competencies related to co-ordinating and integrating both pertain to actually affecting change in the organization. As the ability of individuals to participate in change processes have contributed to successful organizational change in healthcare [70,77], the following is theorized:

\[ P6a-b: \text{Effective Participation of Information Technology Projects will positively impact a) Integrating and b) Co-ordinating DCs} \]

### 5. Discussion and Conclusion

The purpose of this article is to propose a theoretical model that explains the contribution of HICs of workers have on the performance of healthcare organizations. As there is a need for healthcare organizations to be more flexible and adaptive to address emerging problems in their environments [83], the DCs view [84,85] was employed, and is potentially generalizable to all healthcare organizations that face the need to change due to quality improvement, system integration, technology adoption or changing demographics. This discussion centers on two issues that are necessary for this model to be validated: emergence of the group-level variables; and methodology used in this study.

#### 5.1 Emergence

When an individual (lower) level variable is posited to influence an group (upper) level variable, the individual level variable must be aggregated for every individual in the group, and treated as a group level variable, with a conceptual meaning distinct of the individual-level variable [46]. In order for the group level variable to manifest, there must be a process of emergence [75] that takes place, and this must be established statistically. In measuring team knowledge, other researchers have average the level of tacit and explicit knowledge at the group level, as used by [33]. This method is justified, as it is considered a sampling of the level of knowledge available to the team. However, in situations when respondents at the individual level self-select, this could result in an inaccurate assessment of available knowledge. Although this approach innovates with the use of multilevel methods to research microfoundations of organizational capabilities, and illustrates the conceptual implications when aggregating individual level data, it does exhibit shortcoming that restricts its applicability to all situations of research when microfoundations are included in such a manner.

Given that these limitations are likely to be present in most projects, the use of mixed methods [13,14] research provides opportunities to contribute to the use of multilevel research to investigate microfoundations, in several ways. First, the emergence of human capital from individual level knowledge, skills and other attributes is recognized as having some unique characteristics, as well as some characteristics that are common with other organizations [71]. The contextualization of quantitative data with qualitative interviews, and its contrasting of high- and low-performers with respect to the emergence of knowledge at the organizational level (as in sequential
explanatory mixed methods research [14]) should be used to provide a rich description as to the processes related to the dissemination of knowledge related to HICs, and its emergence to the group level.

5.2 Methodology

This research will employ a sequential explanatory mixed-methods approach [14,44]. Two phases will comprise this research. The first quantitative phase involves the assessment of HICs in a sample of Canadian paramedics. As well, data for the measurement of organizational-level variables will be sought from paramedic leaders, which include paramedic chiefs and their deputies. The second qualitative phase will utilize in-depth interviews to explore the determinant themes regarding ways in which HICs contribute to DCs, for example. Support for this study by the Ontario Association of Paramedic Chiefs (OAPC) has been attained.

6. References


[41] Joint Committee on Rural Emergency Care. Improving Access to EMS and Health Care in Rural Communities: A Strategic Plan. 2010.


