

The Role of Healthcare Informatics Competencies (HICs) and IT Capabilities for Service Innovation in Paramedicine

Full Paper

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Abstract

Paramedic services in the developed world face several problems, often manifesting in unavailability of ambulances, and other negative effects. Paramedic services are innovating with new service delivery models and technologies, yet the evidence that guides paramedic services in these processes is lacking. The purpose of this paper is to determine how paramedic services innovate, and how that innovation is influenced by technology in particular. This research integrates the Dynamic Capabilities, IT Capabilities and Health Informatics Competencies approaches in a multilevel model to understand this issue in a sample of Canadian paramedic services (n=43). The results suggest that paramedics with higher competencies related to identifying areas for technology understanding and application contribute to the ability of a paramedic service to respond to environmental changes. The relationship between IT and paramedic leadership, and the business expertise of the information technology staff also have an impact on the ability to change.

Keywords

Healthcare Informatics Competencies, Service Innovation, Paramedicine

Introduction

Paramedicine throughout the developed world is undergoing unprecedented transformation to its service delivery model, driven by the need to improve the availability of emergency healthcare resources. These changes are driven by the increase in number of available technologies and service delivery models. Despite the 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 is low. The purpose of this paper is to determine how paramedic services innovate, and how that innovation is influenced by technology in particular. This first section provides an overview of the changes taking place in paramedicine. Second, an overview of the theoretical approach and model is presented. The third section outlines the qualitative methodology used in this research, followed by the results and discussion.

Background – Problems and Emerging Changes in Paramedicine

Paramedic services in the developed world face several problems, which compel them to innovate. These problems often manifest in medically unnecessary transports (Billittier et al. 1996), offloading delays in Emergency Departments (EDs; Drummond 2002), or excessive use of paramedic services by specific individuals (Norman et al. 2016), contributing to unavailability of ambulances (Browett 2011). To address these problems, two general approaches that can be taken, although these approaches are not mutually exclusive. First, the paramedic service may introduce new service delivery models that differ from the traditional model characterized by *responding* to calls, administering *treatment* to patients on scene as needed, and if needed, *transporting* them to EDs for further treatment (Dick 2003). Many of the newer

service delivery models employed by paramedic services utilize paramedics in a non-emergency manner to reduce utilization of 911 calls, paramedic deployments and/or transports, in a manner that is locally relevant. This may entail the deployment of paramedics in remote clinics (Blacker et al. 2009; Picard 2014), nursing homes (Moulton 2011), provide paramedics with the tools to perform follow-ups (Browett 2011), or divert calls from an ED to a more suitable healthcare resource (Olynyk et al. 2010).

The second approach taken by paramedic services is to adopt new technology. These new technologies include electronic patient care reports (ePCRs; analogous to Electronic Medical Records; Cohen 2013), and associated data mining and business intelligence applications. They also include next generation 911 (NG911) technologies that enhance the capabilities of both dispatchers and paramedics (Canadian Interoperability Technology Interest Group (CITIG) 2016). Finally, these technologies include a myriad of devices and smartphone apps that will directly impact the work of paramedics, such as drones (Katz 2015), smart defibrillators (Hansen et al. 2014), and many others.

Gaps in the Research

Given these challenges, there are several gaps in research to be addressed. 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 examined 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 (Hu et al. 1999; Liang and Wu 2010; Timmons 2003). Paramedics have infrequently been the subject of these topics. Although concepts that capture attitudes towards technology have contributed much to the field of information systems, the shortcoming is that none of these concepts *capture the knowledge and skills needed by these healthcare professionals to facilitate innovation and change, with technology as part of the context*. These skills and knowledge may entail much more than just the appraisal of a single technology, or the confidence that one can use technology.

Second, there is a lack of research 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 to its complexity, potential dire results for mistakes, and other factors. Various organizational models for guiding quality improvement have been applied in healthcare contexts (eg. Antony et al. 2012; Berwick 2003; Singh et al. 2011; Sittig and Singh 2010). However, there seems to be a lack of research that has applied any of these models in the paramedicine context.

The following research questions will guide this research, focusing on three pertinent themes related to the ability to innovate:

RQ1: Does a healthcare organization's ability to change and integrate with other organizations influence its ability to innovate?

RQ2: Do IT Provider related capabilities influence a healthcare organization's ability to innovate?

RQ3: Do the technology-related knowledge and skills possessed by healthcare workers influence the ability of their respective healthcare organizations to innovate?

Theoretical Approach

This research integrates several theoretical approaches. First, Dynamic Capabilities (DC) focuses on the organizational routines that reconfigure operational processes to address changing forces in the environment, and their contribution to performance (Eisenhardt and Martin 2000; Teece 2007; Teece et al. 1997). Building on Teece (2007; 1997), Pavlou and El Sawy (2011) propose a general framework and formative construct containing four dimensions of DC. *Sensing* includes routines that sense important changes in the environment. *Learning* entails the contextualization of new knowledge to operational processes. *Integrating* entails the sharing of new knowledge throughout the organization. *Coordinating* involves the coordination of resources to affect change.

Second, the Competencies approach (McClelland 1973; Mirabile 1997) entails evaluation of employees based on skills and knowledge needed to occupy a defined role. This approach has been used to broadly capture the skills and knowledge needed by healthcare staff to use technology and information in healthcare. This is referred to as Healthcare Informatics Competencies (HICs), and most notably has been applied to nursing (eg. Hunter, McGonigle, & Hebda, 2013).

Third, IT Capabilities refer to the organizational processes related to the exploitation of technological resources in the control of the firm (Bharadwaj 2000; Grant 1995). This is an adaptation of the Resource Based View (RBV) of the firm 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). This study focuses on only two relevant IT Capabilities. Relationship Infrastructure 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). IT Business Expertise refers to the domain-related expertise possessed by the IT department (Sambamurthy and Zmud 1997).

Model Development

Several hypotheses are presented to answer each of the research questions. RQ1 will be addressed by Hypotheses 1 and 1a, RQ2 will be addressed by Hypotheses 2 through 3, and RQ3 will be addressed by Hypotheses 4 through 6. These hypotheses are described below.

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 and Martin 2000; Teece et al. 1997), has been supported in diverse contexts (Chen and Chang 2013; Loeffsten 2014; Pavlou and El Sawy 2011). Performance here is adapted from the Service Innovation Performance (SIP) variable (Menor and Roth 2007), which captures the degree to which companies believe that they successfully implement services that match their customers' needs better than their competition. Therefore:

H1: Dynamic Capabilities positively impact Service Innovation Performance.

Integration with Other Healthcare Services

Given that some argue for the relaxation of exclusivity when it comes to medical scope of practice (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). Integration with other community partners has been linked to operational (Wong et al. 2011) and strategic (Sanders 2005) performance. Therefore:

H1a: Integration with other healthcare organizations amplifies the relationship between Dynamic Capabilities and Service Innovation Performance.

IT Capabilities

The Integrating Capabilities of the paramedic service will also benefit from a good Relationship Infrastructure between the IT and paramedic leadership. An outcome of Integrating Capabilities is a coherent shared mental model among all employees (Teece 2007). A healthy relationship infrastructure allows for knowledge to be more effectively accessed and shared between IT and functional leadership (Martin 2010; Tsai 2001). Therefore:

H2a: Relationship Infrastructure positively impacts Sensing Capabilities.

The quality of this relationship between IT and paramedic leadership will influence the quality of the shared model with respect to its understandability among frontline staff (Zahra et al. 2006). Therefore:

H2b: Relationship Infrastructure positively impacts Integrating Capabilities.

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 and Grover 2005), organizational IT-dependent strategic agility (Fink and Neumann 2007), process oriented DCs (Kim et al. 2011), and intention to form partnerships with business clients (Bassellier and Benbasat 2004). It is believed that the IT staff business expertise can assist the organization in forming and understanding a shared mental model of changes. Therefore:

H3a: IT Business Expertise positively impacts Integrating Capabilities.

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. Given that IT Business Experience is shown to impact success of IT projects (Fisk et al. 2010; Tesch et al. 2009), competitive advantage (Bhatt 2003; Bhatt and Grover 2005), organizational IT-dependent strategic agility (Fink and Neumann 2007), it is assumed that the effectiveness of efforts to coordinate change will be enhanced by the ability of IT staff to understand contextual issues in times of change. Therefore:

H3b: IT Business Expertise positively impacts Co-ordinating Capabilities.

Healthcare Informatics Competencies

Before hypotheses involving informatics competencies are presented, factors in the dataset must be detected, and their emergence to the group level must be assured. An Exploratory Factor Analysis (EFA; Bryant and Yarnold 1995) was performed on the HIC items with the responses from paramedics who participated in the study to discover HIC factors (more details regarding the collection of this data are detailed in the Methodology sections, below). The sample size ($n=502$) is regarded as suitable to produce stable results (Guadagnoli and Velicer 1988). The Kaiser-Meyer-Olkin (KMO; Kaiser 1970) measure of sample adequacy ($KMO=0.97$) and Bartlett's (1954) test of sphericity ($p < 0.000$) both suggest that EFA is suitable for this dataset. Missing cases were deleted pairwise, and varimax rotation was used. Three factors with eigenvalues greater than 1 emerged, explaining 50.19%, 6.98% and 5.55% of the variance, respectively. These factors were labeled "Technology Application Competencies" (TAC), "Understanding of the Workings of Technology" (UWT), and "Information Processing Competencies" (IPC) respectively.

The Intraclass Correlation (ICC(1) and ICC(2); Shrout and Fleiss 1979), and the within-group agreement ($r(wg)$; Bliese 2000) were calculated to ensure that the factors emerged to the group level. All average $r(wg)$ (TAC=0.73; IPC=0.72; UWT=0.78) exceeded the recommended threshold of 0.7 (Bliese 2000). Some of the ICC(1) (TAC=0.03; IPC=-0.06; UWT=0.09) and ICC(2) (TAC=0.11; IPC=-0.26; UWT=0.28) values are below previously published thresholds of 0.06 and 0.5 (Liao and Chuang 2004). The researchers still proceed with aggregation, considering that wide natural variance in cluster sizes can result in a negative ICC (Hox 2002), and the recommendation to consider all factors when aggregating, including the strong $r(wg)$ result. (Dixon and Cunningham 2009). The limitations herein are acknowledged.

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 and Hyland 2002; Hyland et al. 2003; Singh et al. 2011). Indeed, environmental information comes into the organization via individual organizational members (Cadwallader et al. 2010; Hargadon and Sutton 1997; Singh et al. 2011), where it can then be appraised and acted upon. It is theorized that group-level TAC will impact Sensing Capabilities because an organization with more staff that have a higher ability to understand what and where technology can be applied for improvement. Therefore:

H4a: Technology Application Competencies positively impacts Sensing Capabilities.

H4b: Technology Application Competencies positively impacts Learning Capabilities.

Information Processing Competencies

Sensing Capability includes routines pertaining to surveying the environment for opportunities (Tece 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 as well as contextualizing information 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: Information Processing Competencies positively impacts Sensing Capabilities.

H5b: Information Processing Competencies positively impacts Learning Capabilities.

Understanding of the Workings of Technology

The UWT factor captures some fundamental technical skills. This is important, as technical knowledge is necessary for the ability to recognize opportunities (Nonaka and 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: Understanding of the Workings of Technology positively impacts 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 and Levinthal 1990). Therefore:

H6b: Understanding of the Workings of Technology positively impacts 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 and 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: Understanding of the Workings of Technology positively impacts Co-ordinating Capabilities.

Methodology

Participants and Instruments

The Paramedic Leader population is defined as those that are currently in leadership positions at Canadian land-based paramedic services. Paramedics were recruited through the regular communication channels at participating services, such as message boards, email lists, posters and listservs. For Paramedic Leaders, the questionnaire contained items adapted from 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 HIC questionnaire was adapted from O'Carroll (2002). All instrument items were validated by several academics and practitioners, and a pair of paramedic leaders and paramedics also piloted the test before deployment.

Results

Data collection took place between November 2014 to April 2016. Requests were made to 188 Canadian land-based paramedic services to participate in the study, via email and telephone. 64 attempts were

made, and 53 services completed the questionnaire. Of these, 43 questionnaires were usable and therefore retained for the study, each participant responding per paramedic service. This meets the power requirement ($f^2=0.35$, $\rho=0.8$, $\alpha=0.05$). Out of these services, 502 paramedic responses were completed. **Table 1** (below) details the demographics of the paramedic services and paramedics.

Paramedics (n=502)	
Province	Alberta (43) Manitoba (58) Newfoundland and Labrador (14) Ontario (333) Saskatchewan (44) Blinded Territory (10)
Gender	Male (335) Female (156) na (11)
Experience	Mean: 11.8 years. Standard Deviation: 8.9. Min: 0. Max: 37.
Paramedic Leaders (n=43)	
Province	Alberta (2) MB (5) Newfoundland and Labrador (3) Ontario (24) Saskatchewan (8) Blinded Territory (1)
# Staff	Mean: 195. Standard Deviation: 217.8. Min: 17. Max: 960
Staff Hours	Mean: 221,798. Standard Deviation: 393,780. Min: 13,000. Max: 2,080,000.

Table 1: Description of sample.

Measurement Model

WarpPLS 5.0 was used to estimate the measurement model, as it can assess non-linear relationships (Kock 2015), which were found to be present in the data. The measurement model was refined according to Hair et al. (2013). Several indicators were dropped 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*. The AVEs for each construct are all greater than 0.5. which also suggests a sufficient level of convergent validity.

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; AFCVIF=2.947 < 3.3) (Kock 2015). As all block VIFs are below the 5.0 threshold, it is assumed that collinearity is not an issue (Hair et al. 2013).

Figure 1 (below) summarizes the structural model.

Discussion and Conclusion

The purpose of this paper is to determine how paramedic services innovate, and how that innovation is influenced by technology in particular. Addressing RQ1, the hypothesized relationship between DCs and SIP was strongly supported, and this is a finding that is found elsewhere in the literature (Chen and Chang 2013; Pavlou and El Sawy 2011). Addressing RQ2, the hypothesized relationship between Relationship Infrastructure and Integrating Capabilities is significant, suggesting the 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*. As well, IT Business Expertise is a significant antecedent to Coordinating Capabilities, suggesting that interaction between paramedics and IT staff matters are most involved *when system changes are actually happening*.

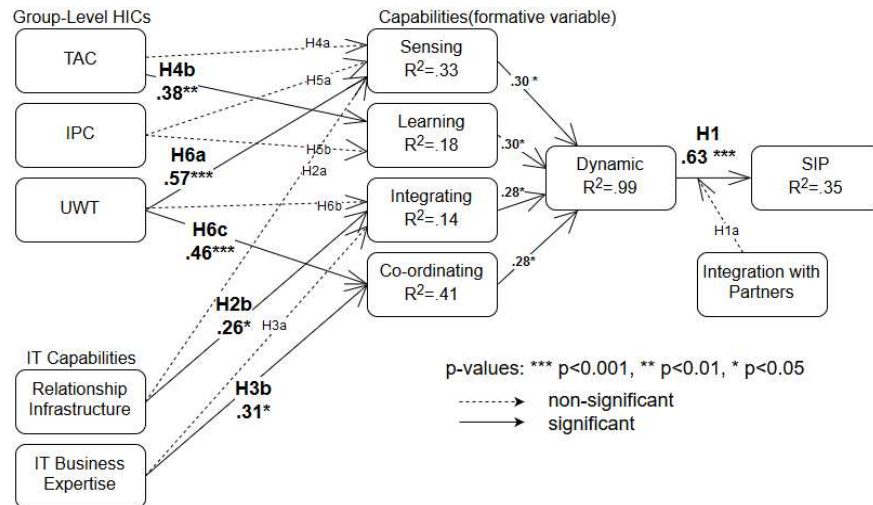


Figure 1: Structural Model Test Results.

The support of some of the hypotheses that address RQ3 suggest that *some healthcare informatics competencies shared among paramedics support some organizational capabilities more than they do others*. The factor labeled TAC was significantly related to Learning Capabilities, suggesting 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 was significantly related to Sensing and Co-ordinating Capabilities, suggesting that understanding of technology by healthcare workers is important when gathering information about new innovations, and implementing them. 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.

Limitations to the study include the use of self-selected participants and policy barriers to deploying the study in certain regions, the use of a pre-existing HIC model not designed for paramedics, and the aforementioned statistical limitations. This study underlines the importance of particular HICs of healthcare staff to specific aspects of organizational performance to both researchers and practitioners, and sets a precedent for linking individual HICs to organizational performance measures.

References

- Ammenwerth, E., Mansmann, U., Iller, C., and Eichstädter, R. 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* (10:1), pp. 69–84.
- Antony, J., Bhuller, A. S., Kumar, M., Mendibil, K., and Montgomery, D. C. 2012. “Application of Six Sigma DMAIC methodology in a transactional environment,” *International Journal of Quality & Reliability Management* (29:1), pp. 31–53 (doi: 10.1108/02656711211190864).
- Bartlett, M. S. 1954. “A Note on the Multiplying Factors for Various χ^2 Approximations,” *Journal of the Royal Statistical Society (Series B)* (16:2), pp. 296–298.
- Bassellier, G., and Benbasat, I. 2004. “Business Competence of Information Technology Professionals: Conceptual Development and Influence on IT-Business Partnerships,” *Management Information Systems Quarterly* (28:4), pp. 673–694.
- Berwick, D. M. 2003. “Disseminating Innovations in Health Care,” *Journal of the American Medical Association* (289:15), pp. 1969–1975.
- Bharadwaj, A. S. 2000. “Resource-Based Perspective on Information Technology Capability and Firm Performance: An Empirical Investigation,” *Management Information Systems Quarterly* (24:1), pp. 169–196.
- Bhatt, G. 2003. “Managing Information Systems Competence for the Competitive Advantage: An Empirical Analysis,” in *Proc. of ICIS*.

- Bhatt, G., Emdad, A., Roberts, N., and Grover, V. 2010. "Building and Leveraging Information in Dynamic Environments: The Role of IT Infrastructure Flexibility as Enabler of Organizational Responsiveness and Competitive Advantage," *Information & Management* (47:7–8), Elsevier B.V., pp. 341–349 (doi: 10.1016/j.im.2010.08.001).
- Bhatt, G., and Grover, V. 2005. "Types of Information Technology Capabilities and Their Role in Competitive Advantage: An Empirical Study," *Journal of Management Information Systems* (22:2), pp. 253–277.
- Billittier, A. J., Moscati, R., Janicke, D., Lerner, E. B., Seymour, J., and Olsson, D. 1996. "A Multisite Survey of Factors Contributing to Medically Unnecessary Ambulance Transports," *Academic Emergency Medicine* (3:11), Blackwell Publishing Ltd, pp. 1046–1050 (doi: 10.1111/j.1553-2712.1996.tb03352.x).
- Blacker, N., Pearson, L., and 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 *Implications for Data Aggregation and Analysis* K. J. Klein and S. W. Kozlowski (eds.), San Francisco, CA: Jossey-Bass, pp. 349–381.
- De Boer, M., Van Den Bosch, F. A. J., and Volberda, H. W. 1999. "Managing Organizational Knowledge Integration in the Emerging Multimedia Complex," *Journal of Management Studies* (36:3), Blackwell Publishers Ltd, pp. 379–398 (doi: 10.1111/1467-6486.00141).
- 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/o/Sep21EDRMS_n213443_v1_HES11014_CREMS_Pilot_Project_Update.pdf).
- Bryant, F. B., and Yarnold, P. R. 1995. "Principal-Components Analysis and Exploratory and Confirmatory Factor Analysis.," in *Reading and Understanding Multivariate Statistics* L. G. Grimm and P. R. Yarnold (eds.), Washington, DC: American Psychological Association, pp. 99–136.
- Cadwallader, S., Jarvis, C., Bitner, M., and Ostrom, A. 2010. "Frontline employee motivation to participate in service innovation implementation," *Journal of the Academy of Marketing Science* (38:2), pp. 219–239 (available at http://resolver.scholarsportal.info/resolve/00920703/v38i0002/219_femtpisii.xml).
- Canadian Interoperability Technology Interest Group (CITIG). 2016. "700 MHz Broadband for Mission Critical Public Safety Data," (available at <http://action700.ca>; retrieved June 22, 2016).
- Chen, Y.-S., and Chang, C.-H. 2013. "The Determinants of Green Product Development Performance: Green Dynamic Capabilities, Green Transformational Leadership, and Green Creativity," *Journal of Business Ethics* (116), pp. 107–119.
- 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* (38:11), pp. 58–59 (available at <http://www.ncbi.nlm.nih.gov/pubmed/24475623>).
- Cohen, W. M., and Levinthal, D. A. 1990. "Absorptive Capacity: A New Perspective on Learning and Innovation," *Administrative Science Quarterly* (35:1), p. 128 (doi: 10.2307/2393553).
- Davison, G., and Hyland, P. 2002. "Palliative Care Teams and Organizational Capability," *Team Performance Management* (8:3/4), pp. 60–67.
- Dick, W. F. 2003. "Anglo-American vs. Franco-German Emergency Medical Services System," *Prehospital and Disaster Medicine* (18:1), pp. 29–35 (available at <http://www.ncbi.nlm.nih.gov/pubmed/14694898>).
- Dixon, D. R., and Stewart, M. 2000. "Exploring Information Technology Adoption by Family Physicians: Survey Instrument Valuation.," in *AMIA Annual Symposium Proceedings*, Los Angeles, CA, USA, January, pp. 185–189 (available at <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2243739&tool=pmcentrez&rendertype=abstract>).
- Dixon, M. A., and Cunningham, G. B. 2009. "Data Aggregation in Multilevel Analysis: A Review of Conceptual and Statistical Issues," *Measurement in Physical Education and Exercise Science* (20:2), pp. 37–41.
- Drummond, A. J. 2002. "No Room at the Inn: Overcrowding in Ontario's Emergency Departments," *Canadian Journal of Emergency Medicine* (4:2), pp. 91–97.
- Eisenhardt, K. M., and Martin, J. 2000. "Dynamic Capabilities: What Are They?," *Strategic Management Journal* (21:8), pp. 1105–1121.
- Epstein, I. E., Kazanjian, A., and 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>; retrieved April 20, 2016).
- Eysenbach, G. 2001. "What is Ehealth?," *Journal of Medical Internet Research* (3:2), p. e20 (available at <http://www.jmir.org/2001/2/e20/>).
- Fink, L., and Neumann, S. 2007. "Gaining Agility through IT Personnel Capabilities: The Mediating Role of IT Infrastructure Capabilities," *Journal of the Association for Information Systems* (8:8), pp. 440–462.
- Fisk, A., Berente, N., and Lyytinen, K. 2010. "Boundary Spanning Competencies and Information System Development Project Success," in *Proc. of ICIS 2010*, St. Louis, Missouri, USA.
- Grant, R. M. 1995. *Contemporary Strategy Analysis*, Oxford, UK: Blackwell Publishers Inc.
- Guadagnoli, E., and Velicer, W. F. 1988. "Relation of Sample Size to the Stability of Component Patterns," *Psychological Bulletin* (103:2), pp. 265–275.
- Hair, J. F., Hult, G. T. M., Ringle, C. M., and Sarstedt, M. 2013. *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*, Thousand Oaks, USA: SAGE.
- Hansen, M. B., Lippert, F. K., Rasmussen, L. S., and Nielsen, A. M. 2014. "Systematic Downloading and Analysis of Data from Automated External Defibrillators Used in Out-of-Hospital Cardiac Arrest," *Resuscitation* (85:12), pp. 1681–1685 (doi: 10.1016/j.resuscitation.2014.08.038).
- Hargadon, A., and Sutton, R. I. 1997. "Technology Brokering and Innovation in a Product Development Firm," *Administrative Science Quarterly* (42:4), pp. 716–749 (doi: 10.2307/2393655).
- Hox, J. 2002. *Multilevel Analysis: Techniques and Applications*, Mahwah, NJ: Lawrence Erlbaum Associates.
- Hu, P. J., Chau, P. Y. K., Sheng, O. R. L., and Tam, K. Y. 1999. "Examining the Technology Acceptance Model Using Physician Acceptance of Telemedicine Technology," *Journal of Management Information Systems* (16:2), Routledge, pp. 91–112.
- Hunter, K. M., McGonigle, D. M., and 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* (3:12), pp. 70–80.
- Hyland, P., Davidson, G., and Sloan, T. 2003. "Linking Team Competencies to Organisational Capacities in Health Care," *Journal of Health Organization and Management* (17:3), pp. 150–163.
- Kaiser, H. F. 1970. "A Second Generation Little Jiffy," *Psychometrika* (35:4), pp. 401–415.
- Katz, A. 2015. "News: Drones: The (Possible) Future of Medicine," *Emergency Medicine News* (37:9), p. 1 (doi: 10.1097/01.EEM.0000471518.70764.7d).
- Kim, G., Shin, B., Kim, K. K., and Lee, H. G. 2011. "IT Capabilities, Process-Oriented Dynamic Capabilities, and Firm Financial Performance," *Journal of the Association for Information Systems* (12:7), pp. 487–517.
- Kock, N. 2015. *WarpPLS 5.0 User Manual*, Laredo, TX: ScriptWarp Systems (available at http://cits.tamui.edu/WarpPLS/UserManual_v_5_0.pdf).
- Liang, J., and Wu, S. 2010. "Nurses' Motivations for Web-based Learning and the Role of Internet Self-efficacy," *Innovations in Education and Teaching International* (47:1), Routledge, pp. 25–37 (doi: <http://dx.doi.org/10.1080/14703290903525820>).
- Liao, H., and Chuang, A. 2004. "A Multilevel Investigation of Factors Influencing Employee Service Performance and Customer Outcomes," *Academy of Management Journal* (47:1), pp. 41–58.
- Loefsten, H. 2014. "Product innovation processes and the trade-off between product innovation performance and business performance," *European Journal of Innovation Management* (17:1), pp. 61–84.
- Martin, J. 2010. "Dynamic Managerial Capabilities and the Multibusiness Team: The Role of Episodic Teams in Executive Leadership Groups," *Organization Science* (22:1), pp. 118–140.
- McClelland, D. C. 1973. "Testing for Competence Rather than for 'Intelligence,'" *The American Psychologist* (28:1), pp. 1–14.
- Menor, L. J., and Roth, A. V. 2007. "New Service Development Competence in Retail Banking: Construct Development and Measurement Validation," *Journal of Operations Management* (25:4), pp. 825–846 (doi: 10.1016/j.jom.2006.07.004).
- Mirabile, R. J. 1997. "Everything you Wanted to Know about Competency Modeling," *Training and Development* (August), pp. 73–77.
- Moulton, D. 2011. "Paramedic program reducing emergency room congestion.," *CMAJ: Canadian Medical Association journal = journal de l'Association medicale canadienne* (183:10), pp. E631-2 (doi: 10.1503/cmaj.109-3897).

- Narasimhan, R., and 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* (20:3), pp. 303–323.
- Nonaka, I., and Toyama, R. 2007. "Strategic Management as Distributed Practical Wisdom (Phronesis)," *Industrial and Corporate Change* (16:3), pp. 371–394 (doi: 10.1093/icc/dtm014).
- Norman, C., Mello, M., and Choi, B. 2016. "Identifying Frequent Users of an Urban Emergency Medical Service Using Descriptive Statistics and Regression Analyses.," *The western journal of emergency medicine* (17:1), California Chapter of the American Academy of Emergency Medicine (Cal/AAEM), pp. 39–45 (doi: 10.5811/westjem.2015.10.28508).
- O'Carroll, P. 2002. "Informatics Competencies for Public Health Professionals," Seattle, WA, USA (available at <http://www.nwcphp.org/phi/comps>; retrieved May 14, 2016).
- Olynyk, C., Thurston, A., and Klitch, J. 2010. "Community Referrals by EMS: An Extension of Service," Toronto, ON, Canada (available at [http://ircp.info/Portals/11/Downloads/Expanded Role/Toronto CREMS/CREMS/CREMS Presentation November 2010.pdf](http://ircp.info/Portals/11/Downloads/Expanded%20Role/Toronto%20CREMS/CREMS/CREMS%20Presentation%20November%202010.pdf); retrieved May 2, 2016).
- Paterson, W. G., Depew, W. T., Paré, P., Petrunia, D., and Switzer, C. 2006. "Canadian consensus on medically acceptable wait times for digestive health care," *Canadian Journal of Gastroenterology* (20:6), pp. 411–423.
- Pavlou, P. A., and El Sawy, O. A. 2011. "Understanding the Elusive Black Box of Dynamic Capabilities," *Decision Sciences* (42:1), pp. 239–273.
- Picard, A. 2014. "Why Community Paramedicine Saves Both Money and Lives," *The Globe and Mail* (available at <http://www.theglobeandmail.com/life/health-and-fitness/health/why-community-paramedicine-saves-both-money-and-lives/article16905592/>).
- Ross, J. W., Beath, C. M., and Goodhue, D. 1996. "Develop Long-Term Competitiveness through IT Assets," *Sloan Management Review* (38:1), pp. 31–45.
- Sambamurthy, V., and Zmud, R. W. 1997. "At the Heart of Success: Organization wide Management Competence," in *Steps to the Future: Fresh Thinking on the Management of IT-Based Organizational Transformation*. C. Sauer and P. Yetton (eds.), 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* (41:2), pp. 4–13.
- Shrout, P. E., and Fleiss, J. L. 1979. "Intraclass Correlations: Uses in Assessing Rater Reliability," *Psychological Bulletin* (86:2), pp. 420–428.
- Singh, R., Mathiassen, L., Stachura, M. E., and Astapova, E. V. 2011. "Dynamic Capabilities in Home Health: IT-Enabled Transformation of Post-Acute Care," *Journal of the Association for Information Systems* (12:2), pp. 163–188.
- Sittig, D. F., and Singh, H. 2010. "A New Sociotechnical Model for Studying Health Information Technology in Complex Adaptive Healthcare Systems," *Quality & Safety in Health Care* (19 Suppl 3), pp. i68–i74 (doi: 10.1136/qshc.2010.042085).
- Teece, D. J. 2007. "Explicating Dynamic Capabilities: The Nature and Microfoundations of (Sustainable) Enterprise Performance," *Strategic Management Journal* (29), pp. 1319–1350.
- Teece, D. J., Pisano, G., and Shuen, A. 1997. "Dynamic Capabilities and Strategic Management," *Strategic Management Journal* (18:7), pp. 509–533.
- Tesch, D., Sobol, M. G., Klein, G., and Jiang, J. J. 2009. "User and developer common knowledge: Effect on the success of information system development projects," *International Journal of Project Management* (27), pp. 657–664.
- Timmons, S. 2003. "Nurses Resisting Information Technology," *Nursing Inquiry* (10:4), Blackwell Publishing Ltd., pp. 257–269 (doi: 10.1046/j.1440-1800.2003.00177.x).
- 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* (44:5), pp. 996–1004.
- Wernerfelt, B. 1984. "A Resource-Based View of the Firm," *Strategic Management Journal* (5:2), pp. 171–180 (doi: 10.1002/smj.4250050207).
- Wong, C. Y., Boon-itt, S., and 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* (29:6), pp. 604–615.
- Zahra, S. A., Sapienza, H. J., and Davidsson, P. 2006. "Entrepreneurship and Dynamic Capabilities: A Review, Model and Research Agenda," *Journal of Management Studies* (43:4), pp. 917–955.