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How Can Physician's Knowledge be Activated to Provide Better Healthcare? Explaining Electronic Health Record Adaptation by Physicians

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Abstract

Despite the rising costs of healthcare and falling quality of care, the integration of EHR (Electronic Health Records) in supporting collaboration to increase the efficiency and effectiveness of healthcare remains a challenge. It appears that the physicians are at the center of this bottleneck. The literature suggests that the reasons for the limited use relate to policy, financial and usability considerations, but it does not provide an understanding of reasons for physicians' limited interaction and adaptation of EHR. Following an analysis of qualitative data, collected in a case study at a hospital using interviews, this research shows how a collaborative technology architecture can enable the physicians to better interact with their partners using the E.H.R technology for the purpose of improving healthcare provision.

1. Introduction

There is increasing pressure to operate efficiently in healthcare. Costs are spiraling out of control, due in part to huge amounts of redundancy and waste [19,20,31]. Research has shown that the healthcare industry is plagued by rapidly increasing costs, poor quality of service, lack of integration of patient care, and lack of information access to EHR [3,5,18,25,29,40]. Medical errors arise because of process failures, ineffective communication and lack of information. It is time to make the best use of new technology in every phase of a patient's experience to drive out efficiencies, eliminate errors and enhance communication. Capturing the benefit from EHRs (Electronic Health Records) can enable collaboration among medical practitioners to ensure hospital care is improved.

According to Gallup (2012), healthcare in America costs 2.5 trillion a year and are expected to grow to 4.5 trillion in six years. The use of information technology (IT) has the potential to help healthcare organizations improve quality of service while reducing costs. The Institute of Medicine (IOM, 2001) reported that the U.S. healthcare system is "fundamentally broken" and called on the federal government to make a major investment in information technology in order to achieve the changes, such as the "commitment to technology to manage the knowledge bases and process of care" [20, p. 178], needed to repair the broken healthcare system. According to the Agency for Healthcare Quality and Research, automation is able to improve the quality and safety of care delivered by healthcare facilities by enabling collaboration. Advances in automation have the potential to improve all aspects of healthcare delivery, from diagnosis and treatment to administration and billing.

Healthcare delivery has been relatively untouched by the revolution in information technology that has transformed nearly every other aspect of society [20,p. 15]. This inability to take full advantage of computerization is unfortunate because EHR has the potential to improve patient care and patient safety. In 2007, however, the American Hospital Association reported that only 11% of hospitals had fully implemented EHR, and these hospitals were likely to be large, urban, and/or teaching hospitals.

Vishwanath & Scamurra reported less than 10% of physicians in different practices and settings in the US use EHR, whereas more than half of the physicians in countries like Sweden, Netherlands and Australia have adopted EHR [52]. Blumenthal (2009) cites only 1.5% of US hospitals have comprehensive EHR systems. A similar 2009 study by the American Hospital Association shows less than 2% of hospitals use comprehensive EHR and about 8% use a basic EHR in at least one care unit. These findings indicate the adoption of EHR continues to be low in US hospitals [11].

The healthcare system is a complex organization characterized by knowledge workers working as independent professionals. The ability for these knowledge workers to access data effectively and efficiently would improve the quality of work processes and patient care. However, EHR, which enable people to work effectively and efficiently access data, have been underused by U.S healthcare professionals such as physicians. In order to improve the use of IT in the U.S. healthcare system, it is necessary to understand what

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healthcare professionals, especially physicians, think about the use of EHR.

While the technology has the potential to increase the quality of healthcare and reduce its costs, it appears a key challenge relating to the content of the electronic health record is the exchange of data, its analysis, and sharing diagnosis and treatment information from the physicians to the people who need it. The multi-disciplinary nature of the healthcare providers and the information they require contributes to the challenge. The research question investigated in this study is *how can adaptation of Electronic Health Records by physicians to collaborate enable better healthcare provision?*

We investigate this question by examining the ways in which adaptation of technology by physicians could enable their knowledge to be activated more effectively and efficiently. This question is investigated through a qualitative study that examines how physicians interact with EHR. The key contribution of this research is discovering the ways in which physicians' adaptation of technology can enable knowledge activation through the use of collaborative tools and processes. Following an analysis of how physicians go through processes of adaptation to activate their knowledge using the Qureshi Keen model [37], this research illustrates how a collaborative technology architecture can enable the physicians to better interact with their partners using the E.H.R technology for the purpose of improving healthcare provision. It does this by drawing upon Paul et al's (2012) ontology illustrating how EHR has the potential to provide continuity of service and could be a tool supporting collaboration as physicians increasingly work with each other and other service providers.

2. Theoretical Background

EHR has the potential to provide continuity of service and could be a tool supporting collaboration as physicians increasingly work with each other and other service providers. Previous technology research [36,37,38,39] has investigated collaboration effects. It provides insight to inform the Physician/EHR research in the areas of collaboration, coordination, communication and adaptation. In addition, the adaptation insights at the work, social and technology levels inform this research.

According to Qureshi and Vogel's model of eCollaboration Effects, when people use technology to work with each other, they go through technological, work, and social processes in order to adapt to new work environments [39]. Collaboration is purposeful joint action through the construction of relevant meanings that are shared by members. Collaboration is needed to: 1) determine what action is required and relevant; 2) identify what knowledge is required to carry out required action; 3) demand for action. In order to support collaboration it is necessary to have a media with which to communicate and a social network or "community of minds".

The adaptation of new technology in collaborative relationships occurs when members of a group learn how new technology affects their work relationships and the work environment [36,38,39]. Successful collaboration requires social adaptation by team members, who must learn to conform to new knowledge, rules, and patterns of interaction.

Physicians using technology go through technological, work and social processes to adapt to new work environments. IT affects work relationships and environments. This is depicted in Figure 1. Work adaptation occurs when people adapt the technology to their own ways of working. The work-adaptation process takes place when groups are involved in changing organizational norms and values while using collaborative technology.

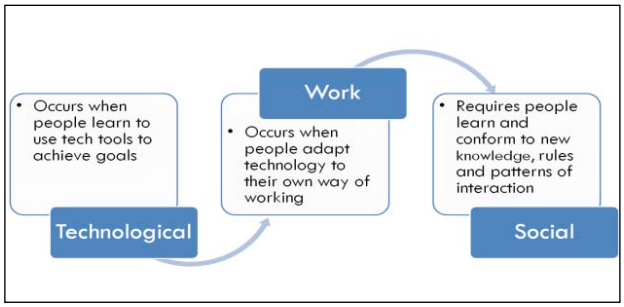

Figure 1: Physician Adaptation Model

IT affects the work process itself and the way in which work is carried out [36,39]. Technology adaptation occurs when people learn how to use technological tools to achieve their goals. The more flexible the technology, the easier it is for people to use the technology to meet their needs. In the context of the ontological framework provided by Paul et al (2012), this Model contributes to an understanding of how the technology architecture can enable physicians to use the electronic health records, which is technological adaptation, to work (work adaptation) together with their partners (social adaptation) using the content available to them using the collaboration media to provide better healthcare.

A key challenge relating to the content of the electronic health record is the exchange of data, its analysis, and sharing diagnosis and treatment information from the physicians to the people who need it. According to Qureshi & Keen (2005), occupational communities can have difficulty sharing information between different domains of knowledge that is dispersed across different

individuals. The healthcare implementation of EHR has similar issues. Information technology solutions, such as the EHR, tend to focus on stimulating knowledge collection by codifying or explicating knowledge. Typically infrastructures are used for storing, managing and distributing explicit knowledge.

However, the theoretical framework of knowledge activation [37], suggests that knowledge use is shaped by three individual knowledge identities: 1) accountable which is part of individuals' professional lives; 2) discretionary which is theirs to share voluntarily; 3) autonomous which forms from their private experience. These identities determine the willingness of people to communicate and share. There are many incentives to share accountable knowledge, which is part of responsibility and position. There is less incentive to share discretionary and autonomous knowledge, which is personal and in many instances can be tacit information the owner is unaware of possessing or the owner may carefully guard as a component of his identity. The three types of knowledge can be activated through collaboration.

Challenges to technological adaptation lie in that the physician perspective is often overlooked. This is reflected in a seminal Simon quote, "This is an old weakness in engineering design, not peculiar to computers: we are fascinated with our technical capabilities and design sophisticated hammers which go around looking for nails that are shaped so as to be hammerable by them (p. 135)."

Challenges to work adaptation can be seen in the reviews of (EHR) literature that show the existing challenges with the alignment of organizational design and the engineered artifact. Niazkhani et al [31, p. 546] concluded "When put in practice, the formal, predefined, stepwise, and role-based models of workflow underlying CPOE systems may show a fragile compatibility with the contingent, pragmatic, and co-constructive nature of workflow." Two of the findings of Greenhalgh et al [19, p. 767] were "while secondary work (audit, research, billing) may be made more efficient by the EPR, primary clinical work is often made less efficient" and "the EPR may support, but will not drive, changes in the social order of the workplace".

The need for work adaptation to enable collaboration can be seen in Fontaine et al's (2010) review of primary care that "The potential for HIE to reduce costs and improve the quality of health care in ambulatory primary care practices is well recognized but needs further empiric substantiation." IOM (2001) claimed that the healthcare system needs to join the IT revolution, and improved information systems may be a critical factor for improving the healthcare system because of the pervasive need to access, record, and share information in order to provide high-quality medical care [20].

Knowledge and learning play important roles in the use of IT, and researchers have developed the diffusion, adoption, and acceptance theories to explain how people adopt, accept, and use complex organizational technologies. Attewell (1992) defined complex organizational technologies as "technologies that, when first introduced, impose a substantial burden on would-be users in terms of the knowledge needed to use these technologies effectively" [4].

Successful adaptation can bring about benefits to the organization. From an organizational learning perspective, Attewell defined technology assimilation as "a process of organizational learning in which individuals and an organization as a whole acquire the knowledge and skills necessary to effectively apply the technology" [16, p. 13,45]. The burden of learning creates a knowledge barrier that inhibits the diffusion of IT. In these cases, the use of IT can be inhibited as much by the ability to adopt IT systems as the desire to adopt these systems. Both these challenges can be overcome through processes adaption that enable collaborative processes to be brought to bear in activating knowledge. The following section describes the methodology used to investigate how adaptation of Electronic Health Records by physicians to collaborate enable better healthcare provision.

3. Research Methodology

This study uses a qualitative research method to examine physician interaction with EHR. It uses Eisenhardt's case study approach, interviews as the primary data collection and open coding for data analysis. The Eisenhardt method was chosen as it: 1) Generates relationships or theory with constant comparison literature; 2) Emergent theory is likely to be testable with constructs that can be readily measured; 3) High likelihood of valid relationships, models or theory because the theory building process is tied to data and other evidence.

The data for this research was collected in a large hospital in the mid-west. This hospital was chosen because of its central location and importance in providing healthcare for the city. Seven physicians were chosen because of their centrality in the hospital's ability provide quality healthcare. The seven interviews and represented 66 pages of electronic transcripts. This data was collected over a period of six months in 2010. This data analysis produced technological, work and social adaptation categories.

Open coding is used to analyze the data and develop concepts as they relate to physician interaction

with EHR. The qualitative method and open coding analysis enables discovery of the relationships in the real world situation. Theoretical sensitivity allows the researcher to have insight into and to give meaning to the events and happenings in data. "Insights do not just occur haphazardly; rather, they happen to prepared minds during interplay with the data [45, p. 47]". Eisenhardt's enfolding the literature step complements the development of sensitivity. "An essential feature of theory building is the comparison of the emergent concepts, theory, or hypotheses with the extant literature [14, p. 544]". This research utilizes theoretical sensitivity and enfolding the literature to develop the lens for the effort and to strengthen the results. That is, it is discovered, developed and provisionally verified through systematic data collection and analysis of data pertaining to that phenomenon [44, p.23]. This approach is consistent with generally accepted approaches to develop relationships or theory from cases [6,14,49,53].

4. Results & Analysis

The following section briefly explores physician adaptation of EHR as a more detailed analysis is given in another paper [32]. More detailed analysis is carried out on collaboration and knowledge activation.

4.1 Physicians Adaptation of EHR

EHR has potential to be a tool supporting collaboration as physicians work with each other and other service providers. An analysis of adaptation at each of the three levels revealed the level the physicians are able to use EHR to support their work practices, level of technological comfort and social interactions/connections. These results are depicted in Table 1.

The results of the coding analysis revealed that an overwhelming majority of occurrences relate to work adaptation. This is an interesting finding in that physician adaptation of the EHR being investigated was very low. Physicians have experienced highly demanding

Table 1: Physician's Adaptation of EHR

Category	Description	Occurrences
Work	The physician perspective of EHR usage on physician work. Subcategories: Positive Work Impact, Negative Work Impact, Productivity.	197
Technological	The Physician perspective on implications of IT Context on EHR usage. Sub-categories: System Development, Hardware & Configuration, Training, Documentation, Desire Integrated Systems, Downtime Concern.	75
Social	The Physician perspective on implications of Social Context on EHR usage.	18
Total		290

educational and specialized training and are experts in their own profession. Findings from prior research suggest physicians are reluctant to give a positive response to implementation of an IS that interferes with their traditional routines [13]. A key element in understanding physician use of EHR is the critical role played by expertise and values in their work processes. Anderson & McDaniel feel professional expertise and values can be powerful inhibitors of innovation.

Technological adaptation amongst physicians appears to be influenced by their level of comfort and experience with technology. While older physicians are opinion leaders with respect to clinical decisions, younger physicians are frequently leaders in using information technology [1].

In addition, the various processes and infrastructure identified in this research case study do not encourage adaptation. Hence, the frustration amongst physicians and their loss in productivity through the use of EHR exists. This is illustrated in their comments below:

"What is currently happening is the clinicians are being asked to pay for it, especially the ones that are on productivity, are being asked to pay for it out of their productivity dollars and they are not going to make a return from it."

"I think that one concern is that you actually spend less face to face time with people whether it's personal family/friend time or patient care, too."

"One of the things we hear with the Computerized Physician Order Entry system we have here, CPOE, is that most providers will tell us that it costs them time."

As illustrated by the above quotes, EHR appears to be a new technology that is considered additional work resulting in reduced productivity by the physicians required to use it. At the same time, the benefits of using these technologies have been touted by administrators and politicians. If the physician has a need to address a problem, the physician will turn to technology or other care providers. The physicians in this research all identified a need for additional interfaces and analysis tools to interface with the data. In fact, they have expressed dissatisfaction with the lack of delivery of these types of tools. An EHR solution must contain more than 'automating' functionality, it must enable 'informating' functionality.

4.2 Physicians Knowledge Activation

It appears in order for adaptation to take place, the knowledge identities of the physicians need to be addressed. In particular, the physicians' ability to care for patients not only depends on their explicit knowledge, professional identity and accountable knowledge, but their intuition and experience. It is their ability to utilize 'sensemaking' [50] that must be emphasized and supported to enable physician work processes. The adaptation of the technology appears to be a barrier to activation of clinical skills and is supported by this research as indicated by the data, such as:

"*…rather than sitting down and thinking "could this be something else, what am I missing, what else could it be?" We don't have time to that anymore, you don't have time to use our clinical skills to take care of our patient."*

"We have a whole generation of physicians coming up that are not as good at their clinical skills. I am not as good at my clinical skills as my elder colleagues. They can walk into a room and diagnose something because they were good clinicians. Now we look at a patient and say what do they have and then we look at the data and make the data fit what we want it to. Does the data fit what it could possibly be rather than I think it's this, what do I need data-wise to confer? And so I think with EHR we are doing a lot of it, we are spending more time trying to find out what it could be with data rather than talking to a patient."

The above quotes illustrate that when the implementation of information systems interferes with physicians' traditional practice routines, they are not likely to be accepted by physicians [2]. According to Anderson, physicians will oppose any systems that impose major limitation on how clinical data is recorded and how the medical record is organized. Physicians feel it interferes with the way they organize their thought processes in caring for patients. Understanding how physicians work with knowledge in the healthcare domain and the knowledge identities they utilize is an important step in understanding the physicians' perspective on EHR usage.

Status and role need to be acknowledged. A physician can be highly valued for abilities unrelated to accountable knowledge. The demand for a particular physician is based on much more than ability to demonstrate accountable knowledge. Often the physician has gained vast amount of discretionary and autonomous knowledge that differentiates them from others. They are able to complete their work processes without specifically realizing every step of their thought processes or every discrete data element under consideration. It is their ability to combine and utilize their knowledge identities and 'sensemaking' processes that enable them to arrive at superior performance.

4.2.1 Activation of Accountable Knowledge. The accountable knowledge is part of the codified knowledge expected in the public identity and responsibility of a physician. It is seen in the interaction with EHR. Physicians have very distinct professional identities. "To be a professional includes three ideals; 1) that one has skill acquired through specialized training; 2) that one can have a rational account of one's own activities, explaining the 'whys'; 3) that one is dedicated to using one's skills for the well-being of others [8, p. 51]". Often the physicians' expertise is based on specialized cognitive knowledge and specialized skills. Historically, physicians have a dominant role in the medical model of healthcare [1,2].

The recording of accountable knowledge with EHR, as indicated below, is relatively easy. However, the physician perspective tends to indicate the entry of accountable knowledge tends to distract them from other thought processes.

" think that a lot of consultants, myself included, because there are so many dot points and so much data that we have to put in extra time that we forget to read what's in there. We are so busy trying to document that we are actually not paying attention to what is in the documentation."

"I think you could do a combo where you had point and click history of present illness, review of systems, past medical history, because all of that stuff is easy. I mean for me to document past medical history, review of systems and family history, that can be point and click, that's not the issue, but when you get down to what your thought process is and what you have done for the patient and when you are saying why it's not a heart attack and you think it's chest wall pain and stuff like that, there is no good way to represent that in a point and click type of thing."

This suggests that the tool to support physicians' accountable knowledge is considered inadequate by them. The findings of Qureshi and Keen (2005) on the knowledge as an identity have implications for physician use of EHR. The EHR appear to have introduced a paradox where the system supports some work processes and not others. The physicians' knowledge paradox is their inability to bring to bear their combined expertise on a particular problem because the processes and infrastructures of EHR force them to codify accountable knowledge. This paradox is illustrated in the quote below by Qureshi and Keen (2005):

"…our perspective on knowledge as identity has the following implications for overcoming the knowledge paradox: first and perhaps most importantly, it defines knowledge as part of the person and thus as highly

situational. Second, the knowledge management challenge is to activate knowledge via networks. Third, knowledge management will move toward achieving its goals by recognizing the needs for multiple activation networks based on the link between knowledge identities and signing up as a member. All of us have accountable, discretionary and autonomous knowledge. The very same knowledge may have entirely different activation features depending on one's identity. Finally, people determine knowledge in action (37, p.13)".

This is the minimum requirement for work practice support and a small or insignificant part of their role as a physician. Physicians appear to need much more than codified, accountable knowledge. The systems they interact with need to facilitate the knowledge conversion from tacit to explicit knowledge and support the activation of accountable, discretionary and autonomous knowledge. It appears from the analysis that there are some knowledge processes that need to be addressed. It appears knowledge processes take place as physicians interact with the EHR. In this case, there is a mismatch between the physician work practices and the processes the EHR support. As a result, there is low adaptation.

When accountable knowledge is not sufficient to satisfy a demand for action, discretionary knowledge is activated [37]. The discretionary knowledge is based on experience and is not represented in any particular document or system. It lies in the interaction with humans. Often the answer to such problems lies in experiential and personalized knowledge held by various members of the organization, but not necessarily related to their job description [37]. Collaboration and relationship are necessary at this level.

4.2.2 Activation of Discretionary Knowledge. There is an indication in the data that the support for discretionary knowledge in the EHR is not sufficient to support this knowledge identity. The physician perspective seems to indicate a loss of interaction opportunity. The focus of entering and representing data tends to overshadow the opportunity for discretionary identity activation. This is illustrated in the quote below:

"And so I think with EHR we are doing a lot of it, we are spending more time trying to find out what it could be with data rather than talking to a patient. "

"I think physicians are spending less time thinking about things and instead of thinking what could be causing chest pain we are trying to think about what are the 16 dots I need to check to meet the standard to get paid and make sure that I look good that any patient can see rather than sitting down and thinking "could this be something else, what am I missing, what else could it be?"

The frustration with some of the physicians is identified by their inability to place information into the system to reflect their higher level discretionary or autonomous thoughts and assessments. The focus of 'what is going on with my patient and providing that level of assessment and detail' is interfered with the thought of 'how do I use this system and click the required fields'. In many cases, information the physician wants to see or wants to record is not intuitively obvious or supported task in the system.

4.2.3 Activation of Autonomous Knowledge. The autonomous knowledge is an individual's private identity. The knowledge is highly personal, tacit and experiential. It is mobilized in personal relationships, friendships, mentoring and types of communities. EHR cannot support his type of knowledge identity. It cannot be codified into databases. Yet, it is a key component of physician identity. This is not an area to incorporate into EHR, but is an area we need to consider when considering physicians adaptation to EHR. EHR requirements and interaction cannot distract physicians from accessing the autonomous knowledge identity. This knowledge identity is often the distinguishing factor between physicians. The quote below illustrates this:

"it's going to be very hard because we all have different brains and we all see things differently, I am a visual person, so when I see it on one sheet and I see all the information I need it is very easy for me to go through that. But to go through page after page after page after page and it's really only a few hours of time doesn't work for my brain. So either I can retool my brain, which I have to do because we are not going to have to have a different system for each provider or I just don't do it."

The above quote suggests that the real challenge with EHR is addressing the needs of physicians to use the EHR to record autonomous knowledge when the interface primarily enables collection of codified information that is contained in the patient records.

In working with other physicians and care providers, physicians bring their knowledge into action while drawing upon the skills and knowledge of their colleagues. This means that in order for a technology to effectively support physicians' work, it would have to have functionalities that enable physicians to identify, contact each other and share their knowledge relevant to their cases. This has implications for how we support the physician in utilizing the system and how we support the physician in enabling them to effectively record their discretionary knowledge. Current systems do not appear to support the level of thought processes and knowledge

requirements going on in their 'brains'. The following quotes illustrate this:

"I am not there every day. I have trouble navigating that particular system. Plus it is not as user friendly; it doesn't think for you, there is too much information, too many boxes of checkmark data that is not appropriate for patient care."

"I like technology when it enhances what I do. I think that technology is the hammer, it is not the person. So, I like technology when it does what I ask it to do, when it doesn't argue with me and when it doesn't make my job harder."

These comments suggest that EHR emphasis appears to be on the codification of the knowledge physicians possess. The systems impinge on the physicians' ability to access or activate discretionary and autonomous knowledge by forcing attention on the codification of knowledge. This is illustrated in the following quotes:

"...I used it for a while and did a couple hundred charts and it was arduous and I felt like it wasn't good narrative, it didn't communicate well to other physicians."

"We are spending less time taking care of the patient and using our mind and more time putting stuff in so that I and the hospital can get reimbursed. So, we are doing a lot of documentation of things for money that doesn't really improve patient care."

"... it (EHR) doesn't think for you, there is too much information, too many check boxes of check mark data that is not appropriate for patient care."

As illustrated above, this focus on the codification of knowledge is detrimental to the provision of healthcare because the physicians use their knowledge identities to arrive at conclusions and decisions. Therefore the support of their knowledge identities is necessary to support the physicians in their work practices.

5. Requirements for Tool Support

It appears that the EHR could provide shared spaces to enable activation of accountable knowledge. The components of the EHR can serve a greater functionality than 'storing' information, but should create 'shared spaces' where the various members of the healthcare team can communicate and create shared understanding. While physicians are utilizing the EHR and focusing on 'accountable knowledge', their skill set, value and differentiation are derived from their discretionary and autonomous knowledge identities. The challenge for developing EHR becomes 'how can EHR activate the necessary physician knowledge?' And if the tool does not meet the physician needs, will the physician choose to adapt to the tool?

Physicians differ from other users of technology in that they are users relying on knowledge, experience and intuition rather than 'database driven facts'. This may be a reason the computer based EHR have met with limited acceptance among physicians [1].When the implementation of EHR interferes with traditional practice routines, they are not likely to be accepted by physicians. This is illustrated in the following quotes:

"I think physicians are spending less time thinking about things and instead of thinking what could be causing chest pain we are trying to think about what are the 16 dots I need to check to meet the standard to get paid and make sure that I look good ."

"...rather than sitting down and thinking 'could this be something else, what am I missing, what else could it be?' and we don't have time to that anymore, you don't have time to use our clinical skills to take care of our patient."

These findings support the conclusion made by Zuboff (p. 9), which states that organization innovations are necessary to support technological innovations if a firm is to fully benefit from the informating process. It is a process that has implications for the kinds of skills that organization members must develop the articulation of roles and functions and the design of systems and structures that support and reward participation in an informated organization.

Physicians need technology to enable them to bring their knowledge identities into action when caring for their patients. Collaboration with other healthcare providers is needed as they activate their knowledge when there is demand for it. Demand for knowledge takes place when there is a condition requiring their specialist skills or a patient presents. Physicians are needed for their specialist skills and knowledge of medical conditions relating to conditions. Technology can be applied to automate certain parts of this process, but cannot always support the process of bringing knowledge into action. Herein lies a role for collaborative technologies in enabling knowledge to be brought into action.

In order to be able to carry out this process of knowledge conversion to make sense of the data retrieved through the EHR physicians' process of adaptation will require their knowledge to be activated. The following section explains the process of knowledge activation and attempts to illustrate how physicians' adaptation of EHR can take place.

6. Improving EHR to Enhance Knowledge Activation

This research has found that the data retrieval and analysis functionality serves as a technology mediator for the EHR. In the context of Paul et al's (2012) ontology, this means that the technology enables the exchange of content to the extent that physicians are

able to use the media. This research has shown that the adaptation processes allow the physicians to use shared spaces and support provided to analyze and interact with the data allowing creation of communication and knowledge from the data. The result is additional capacity for assessment and verification of their accountable knowledge. This means that physicians' diagnosis and treatment options will be of better quality as the system provides more transparency into the use of the content to provide healthcare. This ability to collaborate on diagnosis and treatment options can potentially increased the quality of care.

The discretionary knowledge requires reciprocity and relationship to enable knowledge activation. When there is reciprocity between the diagnosis and treatment options that physicians exchange with the other care providers, the quality of care increases. This research has identified many challenges related to processes and infrastructure that limit the success of this EHR technology mediator. There is an opportunity to improve these processes and infrastructure issues and gain opportunity to provide additional reciprocity and relationship opportunities to evolve.

Activation of Autonomous Knowledge involves trust and personalization. The data indicates dissatisfaction with the lack of personalization available with the EHR and the delays incurred for customization. There is the potential this causes the technology mediator of the EHR provide less support for autonomous knowledge activation. These enhancements to support physician's knowledge activation are illustrated in table 2.

Table 2: Knowledge is Activation with EHR

Knowledge Identities	Use of Technology (EHR)	Technology Mediators	Knowledge in Action (Physician Use–Outcome)
Accountable Knowledge Public	Shared Spaces	Data Retrieval and Analysis	Assess and Verify
Discretionary Knowledge Voluntary	Reciprocity Relationship	Diagnosis and Treatment	Problem Solving
Autonomous Knowledge Private	Trust, Personalization	Social networking	Innovation

Adapted from Qureshi & Keen, (2005).

Physician's accountable knowledge can become more transparent through the shared spaces that support the exchange of data and analysis among physicians and other care providers. Their discretionary knowledge can be supported through the functionalities that enable diagnosis and treatment options to be exchanged with those who need it. The physicians' had significant number of work adaptations to attempt to fit their work processes to the functionality of EHR. Thus, they were able to utilize the EHR as a technology mediator for accountable knowledge activation.

The limited amount of technology adaptation for the activation of discretionary knowledge meant that there was insufficient reciprocity. This would have meant that in return for the physician's knowledge, the other care providers could provide feedback to the physicians as to the accuracy of the diagnosis and effectiveness of the treatments. The social adaptation was also limited. The EHR, in this case, provided limited opportunity for social context and the data indicated system use reduced face to face social opportunities. Adding social networking support to the technology supporting the exchange of medical records would enable the activation of autonomous knowledge. Such collaboration technology features could enable and increase in the effectiveness of treatments by allowing multiple perspectives to be brought to bear on the treatment options. Such social networking and collaboration tools are needed to enable innovations in healthcare provision to be developed and replicated across the board.

This research indicates successful adaptation of the EHR by physicians requires the capacity to enable physicians to activate all three levels of knowledge for use in their work processes. The physician's adaptation of the technology can enable better knowledge activation as they assess and verify the data, solve problems and find innovative solutions to the conditions for which there are few treatments. It is the ability to enable physicians to do more than just record data, but to enable them to share knowledge that is an integral part of themselves' and knowledge they are unaware of incorporating into their awareness. It appears EHR primary strength is to address the explicit accountable knowledge. The majority of physicians' work practices involve their tacit, experiential knowledge which is part of their discretionary knowledge that they bring to bear on their professional responsibilities. The availability and use collaboration tools in the electronic health record system could enable discretionary knowledge to be brought to bear on diagnosis and treatment options thereby increasing the quality of care. Such shared spaces could enable multiple perspectives to be brought to bear on diagnosis and treatment thereby increasing the quality and reducing costs of healthcare provision.

7. Summary & Conclusions

The research has investigated how EHR adaptation by physicians can enable better healthcare provision. It has shown that that EHR has the potential to provide continuity of service and could be a tool for supporting physicians as they work with each other and other service providers. In order to achieve better quality of care, the electronic health records can provide the

transparency needed as they use the technology to exchange content. The physician's adaptation of the technology can enable better knowledge activation as they assess and verify the data, solve problems and find innovative solutions to the conditions for which there are few treatments.

While current technologies for the exchange of medical records support accountable knowledge for the exchange of data and analysis, they do not support the activation of discretionary knowledge which enables diagnosis and treatment. In the context of Paul et al's (2012) ontology, this means that the provision of better healthcare requires adaptation of the technology in order to enable the activation. How to activate physician's knowledge by enhancing the technology supporting the electronic medical record is the key contribution of our research. We have demonstrated the importance of EHR in enabling physicians' knowledge activation and what functionalities can be provided to enhance it. The work processes of the physician, must be considered and their use of accountable, discretionary and autonomous knowledge must be acknowledged and supported.

This research identified the processes for supporting the three knowledge identities for professional users to support adaptation. As the findings of this research connected adaptation and knowledge activation, a natural direction for future research is to expand the research to various types of healthcare organizations and variations of healthcare professionals. This is an increasingly important area for research as we implement IT systems into professional areas.

8. References

[1] Anderson, J. (1997). Clearing the way for physicians' use of clinical information systems. Communications of the ACM, 40(8), 83-90.

[2] Anderson, J. & Aydin, C. (1997). Evaluating the impact of health care information systems. International Journal Technical Assessment in Healthcare, 13(2), 380-393.

[3] Ash, J. S. (1997). Factors affecting the diffusion of the computer-based patient record. Journal of the American Medical Informatics Association Supplement, AMIA Proceedings, 682–686.

[4] Attewell, P. (1992). Technology diffusion and organizational learning: The case of business computing. Organizational Science, 3(1), 1–19.

[5] Barrows, R. C., & Clayton, P. D. (1996). Privacy, confidentiality, and electronic medical records. Journal of the American Medical Informatics Association, 3(2), 139–148.

[6] Baskerville, R. & Myers, D. (2004). Special issue on action research in information systems: Making IS relevant to practice. MIS Quarterly, 28(3), 329-335.

[7] Bates, D. W., Leape, L. L., Cullen, D. J., Laird, N., Petersen, L. S., Teich, J. M., et al. (1999). Effect of computerized physician order entry and a team intervention on prevention of serious medication errors. JAMA, 280, 1311–1316.

[8] Benveniste, G. Professionalizing the Organization. San Francisco, CA: Jossey-Bass, 1987.

[9] Beaudry, A. & Pinsonneault, A. (2005). Understanding user responses to information technology; A coping model of user adaptation. MIS Quarterly, 29(3), 493-524.

[10] Blumenthal, D. (2002). Doctors in a wired world: Can professionalism survive connectivity. The Milbank Quarterly 80(3), 525-546.

[11] Blumenthal, D. (2009). Stimulating the Adoption of Health Information Technology, The New England Journal of Medicine, 360(15), pp. 1477-1479.

[12] Chau, P., & Hu, K. (1998). Identifying early adopters of new IT products: A case of Windows 95. Information & Management, 33, 225–230.

[13] Chau, P. & Hu, H. (2002). Investigating healthcare professionls' decisions to accept telemedicine technology: An empirical test of competing theories. Information & Management, 39, 297-307.

Clifton, J. (2012). Healthcare is killing us. Retrieved from http://businessjournal.gallup.com/content/151862/Healthcare-killing.aspx?utm_source=add+this&utm_medium=addthis.com&utm_campaign=sharing

[14] Eisenhart, K. (1989). Building theories from case study research. Academy of Management Review, 14(2), 532–559.

[15] Fontaine, P. Ross, S.E., Zink, T. Schilling, L.M. 2010. "Systematic Review of Health Information Exchange in Primary Care Practices", J Am Board Fam Med (23), pp. 655–670

[16] Fichman, R., & Kemerer, C. (1997). The assimilation of software process innovations: An organizational learning perspective. Management Science, 43(10), 1345–1363.

[17] Gersick, C. (1988). Time and transition in work teams: Toward a new model of group development. Academy of Management Journal, 31, 9-41.

[18] Ginneken, A. M. (2002). The computerized patient record: Balancing effort and benefit. International Journal of Medical Informatics, 65, 97–119.

[19] Greenhalgh, T., Potts, H.W.W., Wong, G., Bark, P., and Swinglehurst, D. 2009. "Tensions and Paradoxes in Electronic Patient Record Research: A Systematic Literature Review Using the Meta-narrative Method," Milbank Quarterly (87:4), pp. 729-788.

[20] Institute of Medicine, Committee on Health Care in America (IOM). (2001). Crossing the quality chasm: A new health system for the 21st Century. Washington, DC: National Academy Press.

[21] Kidder, T. (1982). Soul of a new machine. New York: Avon.

[22] Klein, H. K., & Myers, M. D. (1999). A set of principles for conducting and evaluating interpretive filed studies in information systems [Special Issue on Intensive Research]. MIS Quarterly, 23(1), 67–93.

[23] Kohli, R. & Kettinger, W. (2004). Informating the clan: Controlling physicians' costs and outcomes. MIS Quarterly, 28(3), 363-394.

[24] Kohn, L., Corrigan, J., & Donaldson, M. (Eds.). (2000). To err is human: Building a safer health system. Washington, DC: National Academy Press.

[25] Lafkey, D. B. (2004). Delivering on the promise of electronic medical records: Opportunities, constraints, and developments. Retrieved May 5, 2005, from http://wfs.cgu.edu/lafkyd/Background_Paper.pdf
[26] Manos, D., (2009). New study shows few hospitals have comprehensive EHR. Healthcare IT News, March 25 2009
[27] Markus, M., & Robey, D. (1988). Information technology and organizational change: Causal structure in theory and research. Management Science, 34(5), 583–598.
[28] McDonald, C. J. (1997). The barriers to electronic medical record systems and how to overcome them. Journal of the American Medical Informatics Association, 4(3), 213–221.
[29] Miller, R. H., & Sim, I. (2004). Physicians' use of electronic medical records: Barriers and solutions. Health Affairs, 23(2), 116–126.
[30] Ondo, K. J., Wagner, J., & Gale, K. L. (2002). The electronic medical record (EMR): Hype or reality? HIMSS Proceedings, 63, 1–12.
Paul, S. Ramaprasad, A., & Wickramasinghe, N. (2012). Call for papers Minitrack: Technology Mediated Collaborations in Healthcare retrieved from: http://www.hicss.hawaii.edu/hicss_46/TechMediatedCL.pdf.
[31] Niazkhani, Z., Pirnejad, H., Berg, M.,& Aarts, J. 2009. "The Impact of Computerized Provider Order Entry Systems on Inpatient Clinical Workflow: A Literature Review," Journal of the American Medical Informatics Association (16:4), pp. 539-549.
[32] Noteboom, C. & Qureshi, S., "Physician Interaction with Electronic Health Records: The Influences of Digital Natives and Digital Immigrants.' In (eds) R.Sprague and J. Nunamaker, The Forty Fourth Annual Hawaii International Conference on System Sciences, IEEE Computer Society Press. 2011.
[33] Pinfield, L. (1986). A field evaluation of perspectives on organizational decision making. Administrative Science Quarterly, 31, 365-388.
[34] Poon, E., Blumenthal, D., Jaggi, T., Honour, M., Bates, D., & Kaushal, R. (2004). From the field: Overcoming barriers to adopting and implementing computerized physician order entry systems in U.S. hospitals. Health Affairs, 23(4), 184–190.
[35] Prensky, M. (2001). Digital natives, digital immigrants. From on the Horizon, 9(5).
[36] Qureshi, S., Liu, M., & Vogel, D. (2005). A grounded theory analysis of e-collaboration effects for distributed project management. In R. Sprague & J. Nunamaker (Eds.), Proceedings of the Thirty Eighth Annual Hawaii International Conference on Systems Sciences, January 3–6, 2005 (pp. 1–10). Waikoloa, HI: IEEE Computer Society Press.
[37] Qureshi, S. and P. Keen. "Activating Knowledge through Electronic Collaboration: Vanquishing the Knowledge Paradox". IEEE Transactions in Professional Communication. Vol 48, Issue 1. Pp: 40- 54, 2005.
[38] Qureshi, S., & Noteboom, C. (2006). Adaptation in distributed projects: Collaborative processes in digital natives and digital immigrants. In R. Sprague & J. Nunamaker (Eds.), Proceedings of the Thirty Ninth Annual Hawaii International Conference on Systems Sciences, January, 4–7, 2006 (pp. 1–10). Kauia, HI: IEEE Computer Society Press.
[39] Qureshi, S., & Vogel, D. (2000b). Organizational adaptiveness in virtual teams. Group Decision and Negotiation, 10(1), 27–46.
[40] Schmitt, K., & Woffard, D. (2002). Financial analysis projects clear returns from electronic medical records. Healthcare Financial Management, January, 52–57.
[41] Schwandt, T. A. (2001). Dictionary of qualitative inquiry (2nd ed.). Thousand Oaks, CA: Sage.
[42] Simon, H. (1997). Models of bounded rationality. Cambridge, Massachusetts: The MIT Press.
[43] Strauss, A. (2004). Remodeling grounded theory. The Grounded Theory Review, 4(1), pp. 4-21.

[44] Strauss, A., & Corbin, J. (1990). Basics of qualitative research: Grounded theory procedures and techniques. Newbury Park, CA: Sage.
[45] Strauss, A., & Corbin, J. (1998). Basics of qualitative research: Techniques and procedures for developing grounded theory. Thousand Oaks, CA: Sage.
[46] Sujansky, W. V. (1998). The benefits and challenges of an electronic medical record: Much more than a "word-processed" patient chart. Western Journal of Medicine, 169(3), 176–183.
[47] Thrall, J. (2004). Quality and safety revolution in health care. Radiology, 233, 3–6.
[48] Tonnesen, A. S., LeMaistre, A., & Tucker, D. (1999). Electronic medical record implementation barriers encountered during implementation. Proceeding to AMIA Symposium, 624–626.
[49] Walsham, G. (1993). Interpreting information systems in organisations. London: Wiley.
[50] Weick, K. (1985). Cosmos vs Chaos: Sense and nonsense in electronic contexts. Organizational Dynamics, xx(), 51-64.
[51] Weick, K., & McDaniel, R.R. "How Professional Organizations Work: Implications for School Organization and Management." In Schooling for Tomorrow Directing Future Reforms to Issues That Count edited by T. Sergiovanni and J.H. Moore Boston, MA: Allyn and Bacon, 1989, pp. 330-55.
[52] Vishwanath, A. & Scarmurra, T. (2007). Barriers to the adoption of electronic health records: using concept mapping to develop a comprehensive empirical model. Health Informatics Journal, 13(2), 119-134.
[53] Yin, R. K. (1984). Case study research: Design and methods. Beverly Hills, CA: Sage.
[54] Zuboff, S. (1985). Automate/informate: The two faces of intelligent technology. Organizational Dynamics, 8 (3), 5-18.