Informatics Solution: Proposal for Implementation of Cloud Based Data Storage

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**Executive Summary**

Northern Ontario Community Hospital (NOCH) is proposing to implement a cloud based data storage solution. This informatics solution allows NOCH to address the data storage challenges identified through system analysis. This cloud-based data storage has been identified as the most cost effective, reliable, secure and feasible solution to the current problem.

IT costs have increased by 25% of the 2015-2016 fiscal year’s budget and continue to rise due to significant increases to medical data storage demand. Many archived paper medical records are not yet digitized and stored in a off hospital site location. The data retrieving process contributes to a 35% in Emergency Department wait times and multiple privacy breach incidents.

The existing paper medical record has the potential for damage, loss, and privacy breach during handling. The electronic data is stored in an on-site data centre, which is at risk for break-ins and requires maintenance to prevent damage from heat, fire and water. The NOCH data center utilizes valuable space which could be transformed into clinical treatment areas.

A system analysis was completed using the assessment phase of Johnson’s Planning Cycle. The only major need identified was the requirement for significantly larger amounts of data storage. The proposed cloud based storage aligns strongly with the business goals of NOCH to reduce spending, increase efficiency and improve information security.

Wetherbe’s PIECES Framework was used to assess the feasibility of cloud storage for NOCH. The cloud was determined to be a successful solution due to its ability to increase performance, information accuracy, cost-effectiveness, information protection, efficiency and improve service.

The change to cloud computing will require no additional hardware components to be purchased by NOCH. As part of the service agreement, Microsoft Azure will provide improved bandwidth to support the increased data transfer. In addition, they will also provide the software and the interface to connect local terminals with cloud servers.

The project will be implemented in 28 weeks with the target go live date on March 31, 2018. As there are no new hardware components and almost no difference in software, there will be negligible training requirements. The changeover will be managed by the core project team and Microsoft Azure, creating a maintenance-free system for NOCH IT staff.

Current staff knowledge levels regarding cloud storage will be determined prior to roll out of the new data storage solution. A time efficient and cost effective in-classroom training will be mandatory for all end-users, with certain end-users designated as super-users to provide training and ongoing support.

The framework of Content, Context, Process will be used to evaluate each phase of the project using surveys and interviews to bring issues and knowledge gaps back to the implementation team. Extra training can be provided by Microsoft or super users as needed.

While cloud storage is viewed as the best option for NOCH moving into the future, there have been some potential issues identified that could affect its success in this environment. However, solutions have been identified to address the each of the issues.

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The discipline of health informatics has developed from the needs of healthcare delivery meeting with solutions from information technology. Health information technology, through the use of information systems, data management practices, as well as clinical guidelines, can be used to solve problems within the healthcare sphere. Advances in information technology have led to innovations in the planning, management and delivery of health care services (HIMSS, 2014).

Health informatics professionals optimize the collection and storage of information in healthcare to improve its use by healthcare professionals (McMaster University, 2017). With the increasing amounts of electronic health information being generated every day, storage solutions for this data have become an important issue. Cloud networking is one solution that has been identified by information technology (IT) professionals and healthcare administrators that can grow to meet a hospital’s storage needs, provide increased accessibility to health information while increasing security and reduce costs.

**Formulation and Scope of Informatics Problem**

Northern Ontario Community Hospital (NOCH) is located in a rural area of Ontario,

Canada, and currently serves a population of approximately 50,000 people. Plans to develop natural resources in the area are expected to grow the population significantly in the next ten years. NOCH is a small hospital that provides emergency, inpatient care and small procedure operations to people of all ages from the surrounding towns nearby. Complex operations and traumas are transferred to a larger hospital when required, and the patients are often transferred back to NOCH when medically stable.

Through a start-up grant by the Canada Health Infoway, NOCH was recently able to

institute an electronic medical record (EMR) for all patients who receive care at the facility (Canada Health Infoway, 2017). Prior to the implementation of the electronic health record, all patient records were written on paper and kept in physical files in a medical records facility on-site, while older files were archived off site. Previously, accessing a patient’s record could be very time consuming and expensive. The medical records office had to be staffed 24 hours a day to retrieve and deliver charts. In the case where an archived chart was required emergently, it could take up to four hours to request the chart, have it retrieved at the off-site storage facility and delivered to the requesting physician. Because of these inefficiencies in data storage and retrieval, some health care providers shared patient information via email. However, files could be large and hard to send, and most professionals recognized concerns with the security of the information within the email system (Information Commissioners Office, n.d.).

Since the implementation of the EMR, as new electronic charts are opened, and information is added to existing ones, the data is transferred and stored in an on-site server room. In addition, the medical records department is currently in the process of scanning each archived paper chart and storing it electronically, increasing the load on the servers. Patient information can now be accessed at any time from any desktop computer within the hospital. Through continuing evaluations, NOCH has found that the majority of staff are satisfied with the change to electronic charting as it has streamlined many processes, and improved patient safety.

The informatics problem that has been identified by AUCH is the need for a data storage solution which is able to grow as the system expands, is secure, reduces IT costs and allows for increased flexibility of access for staff. Unfortunately, the small size of the NOCH has limited the space available to house data storage servers centres on which the ever-increasing amount of patient information is kept. The current server room is near capacity, and administration and the IT department have not found an acceptable way to expand the size. Purchasing, planning and implementing data storage has required the hiring of more IT professionals, straining the human resources budget of the hospital (Ratchinsky, 2016). Additionally, the on-site location of the data servers has left them open to possible security breaches through mechanical failure, break-ins and theft (Hardy, 2010).

**Significance of Informatics Problem**

In the current digital age, there is an expectation that people will be able to access the right information at the right time from anywhere in the world (Thakkar & Davis, 2006). A single electronic health record allows for an improved level of care as all health care providers in a single facility can access and update patient information, including details of patient visits, assessments and treatments (eOntario, 2017). EMR’s have also been proven to increase the quality of patient care, reduce the incidence of medical errors and save significant amounts of money in health care administration (Thakkar & Davis, 2006). Funds that are saved through the implementation of an EMR can then be used to either reduce cuts to other areas, or increase spending in clinical care as needed (Ratchinsky, 2016).

The healthcare industry has additional rules and regulations regarding data storage that are much more stringent than seen in other industries due to the sensitive nature of patient information (DataEndure, 2016). Heightened security regulations, in addition to the need for exceptional performance, has made choosing data storage solutions a difficult process. Data must be accessible at all times as an inability to access patient information due to a hardware failure or event error could impact patient safety (DataEndure, 2016). Storage solutions not only need to store current information, but must also be able to hold archived data to meet data retention policies.

The data storage problems that have been identified by NOCH could be solved through the traditional method of continuing to add hardware to the physical on-site server that is currently being used. However, according to O’Dowd, organizations who are in the process of making changes to their data storage are more likely to switch to cloud storage (2016). Cloud computing has been described as one of the important technological evolutions of current time (Information Technology Group, 2014).

The cloud is a term which describes a large network of physical servers which are located in warehouses anywhere in the world hosting petabytes of data (Estes, 2015). These servers can work together to optimize computing performance in order to provide advanced data processing services to solve problems or power data analysis (Fee, 2013). The other main purpose for cloud computing is to provide large scale data storage to individuals, companies and hospitals. Data can be uploaded to the cloud, but then accessed from anywhere in the world on multiple devices through a Virtual Private Network (VPN) instead of relying on a hard drive for each computer (O’Dowd, 2016).

There are a number of reasons why the use of the cloud by healthcare organizations is growing aggressively with 89% of American health care organizations using cloud based IT infrastructure (DataEndure, 2016). Almost four billion dollars was spent on cloud services in 2015, which is expected to grow to almost 9.5 billion dollars by the year 2020 in the United States (Ratchinsky, 2015). Reasons include economics, expectations for access and sharing of health information and increased security for personal details.

Given the focus by health care organizations on reducing spending and human resources, the cloud is an economical solution. Server rooms have high energy usage to power hardware and air conditioning units to keep rooms at a set temperature (O’Dowd, 2015). The purchase, maintenance and upgrade of physical servers is expensive, and requires highly trained professionals to provide these services (O’Dowd, 2015). Cloud based storage requires no new hardware, and offers savings through renting only the space that is needed on a provider’s servers (O’Dowd, n.d.). In addition, moving storage off-site reduces the number of IT professionals required to be employed by a hospital.

The structured and unstructured data that is being produced by hospitals and health care providers continues to grow due to increasing digitization of records, tests and communication(Hardy, 2010).The storage provided by cloud computing companies is scalable to continuously meet the needs of the customer and is theoretically limitless (DataEndure, 2016). The use of cloud computing storage solutions takes the responsibility off of hospitals to repeatedly plan for increasing storage needs.

The advancement towards EMR’s and the digitization of health information also changes the expectations of health professionals in retrieving specific health data. Any data storage system is now expected to allow for the easy access to a patient’s full chart at all times from anywhere in the hospital to improve patient safety (DataEndure, 2016). Accessibility should not be interrupted by malfunctioning of the storage environment, or lives could be put at risk (DataEndure, 2016).

Next to cost considerations, security is the next most important factor when choosing a data storage system. Cloud storage is located in off-site warehouses dedicated solely to housing servers (Information Technology Group, 2014). There is less worry about destruction of the facility due to other uses, or break ins from people who happen to be in the building. Companies providing cloud storage offer high level encryption to comply with federal regulations for data that is being sent online to prevent hacking information (O’Dowd, 2016).

**System Analysis**

Shortly after the implementation of the EMR at NOCH, the IT staff identified that there would be a time when there would not be enough storage space to contain all of the necessary patient data and carried out a system analysis to fully assess the situation. A system analysis aims to investigate, then describe in detail how the components of a system work together (Athabasca University, 2015). An analysis also measures the current and future requirements of the system in order to plan for upcoming needs (Athabasca University, 2015).

As stated by Johnson (2016), organizational IT planning optimizes the allocation of scarce resources in order to meet anticipated organizational needs. Proper planning by organizations ensures that resources support an IT portfolio that meets many diverse needs (Johnson, 2016). Johnson describes IT planning as a “continuous, cyclical process composed of three phases whose primary purpose is optimum allocation of scarce resources” (2016, p. 56). Please see Appendix A. This three-pronged system analysis was chosen by NOCH to determine their current situation and future needs due to its focus on distributing limited funds to the area most in need.

**The Assessment Phase**

The assessment phase of the planning cycle can begin at any time a member of the IT department feels that a problem can be fixed through an IT solution. This phase of the cycle may uncover a number of significant information and information processing needs, which produces an inventory of projects. Beyond the needs of the organizations, the team must also begin to consider the external forces that may help or hinder during implementation of the change. The IT professionals at AUCH were the first to identify that data storage would soon be a problem after the recent implementation of an EMR. Through discussion within the department and health administrators, some solutions were identified, and environmental forces that could affect the project were considered. These included financial issues, human resources allotments and security policies.

**User Needs**

The needs of an IT department can be assessed during either planned or unplanned events. A high-level needs assessment is carried out, and a detailed assessment is completed on any gaps noted. This detailed assessment will identify specific end user needs. The determination of a need for NOCH came about due to a regular needs assessment that was carried out formally by staff.

**Business Objectives**

As more of the world becomes digitized, an organization’s IT plan can help shape its business goals. The proposed plan of changing the type of data storage by NOCH to cloud networking, from traditional on-site storage will help AUCH meet its goal of reducing the overall costs of providing services to patients. Cloud storage also helps to improve efficiency and information security.

**IT Infrastructure**

NOCH IT staff has recognized that the current storage infrastructure is not sufficient to meet the needs of emerging technology. In planning for the transition from on-site storage to cloud networking, IT staff have considered the hardware and software needs of the change. Fortunately, there will be no new hardware required for cloud storage, and most of the current servers can be removed to free up room for other uses. Any new software will be provided by the company who is successful in securing the tender for the project. Upgrading to the EMR in the past 2 years gave NOCH the opportunity to meet industry IT standards for existing equipment.

**Feasibility of Solution**

Identify the feasibility of cloud-based medical record is an important step during the system planning phase. The purpose of the system feasibility analysis is to investigate and determine the viability of the cloud-based data storage solution. The system feasibility is analyzed using the PIECES Framework developed by James Wetherbe (Whitten & Bentley, 2007). The framework classifies system requirements into six aspects—performance, information, economy, control, efficiency, and services. Upon appraisal of these aspects, cloud-based medical record is a feasible system to address the needs of the organization.

**Performance**

The system performance compares the performance of the current system and the future system needs to perform for the users (Whitten & Bentley, 2007). The accessibility of patient’s medical record is a major challenge for clinicians at NOCH. A patient’s medical record includes electronic and paper based components. The electronic based medical record includes nursing documentation, laboratory and diagnostic imaging reports, which are saved in the existing EMR system. The paper based medical record includes physician orders, consultation reports, and medication administration records, which are stored in an offsite storage location and managed by an outsourced company. If a patient’s paper medical record needs to be accessed, a transportation service needs to be arrange to transfer the medical record to the hospital. The average time to access paper based electronic records is approximately four hours. When comparing with the proposed cloud network, patient’s medical record can be accessed in real-time. In cloud network, the clinicians are not limited by physical location in accessing patient’s medical information. Therefore, the cloud-based system can provide a feasible performance for the clinicians.

**Information**

The information component analyzes the information model that the proposed system need to maintain (Whitten & Bentley, 2007). In the existing information model, a patient’s paper based medical record is saved, stored, and retrieved by using a paper format. The data input, storage, and output is not meeting the needs of the clinicians who need to access patient’s medical record right away when needed. The proposed system provides the cloud-based storage space to store all electronic medical records, which is feasible to provide clinicians with real-time and useful formatted information.

**Economy**

The economy aspect addresses the proposed system implementation and operational cost (Whitten & Bentley, 2007). The existing paper medical record storage solution manages approximately 100,000 active patients’ medical record. The basic cost for outsourcing the storage company is $560,000 each year plus additional fees for retrieving each patient’s record. The total cost for 2016-2017 fiscal year is $706,000 and the projected cost for 2017-2018 fiscal year is $790,000. The cloud-based solution involves transferring existing electronic medical record and uploading new patient’s medical record to the cloud-based server. The cost is $610,000 each year. When comparing the existing medical record management with the cloud-based solution. The cost is 13.6% less than existing management, which demonstrates a very cost-effective and feasible solution for the organization. The detailed cost analysis can be found in Appendix B.

**Control**

The control component focuses on the system security issues (Whitten & Bentley, 2007). The cloud-based medical record storage site has more than one layer of physical security and features like biometric fingerprint scanner to provide physical security. The system also offers VPN firewall to provide enough online security to the system during data transfer. Indeed, the cloud-based medical record provides higher security level than the existing paper record process. The cloud-based medical record storage solution provides adequate controls to protect against fraud and embezzlement and to guarantee the accuracy and security of medical record. Thus, it is feasible to launch the new system.

**Efficiency**

The system efficiency measures the correctness and effectiveness of the system (Whitten & Bentley, 2007). Efficiency is one of the critical components impacts the environment at corporate level, department level, and individual level. The cloud-based medical record is cost-effective for the organization. By decreasing the medical record accessing time, treatment delay can be prevented, and patient’s length of hospital stay can be reduced. Hence, the cloud-based medical record is feasible to promote efficiency for the organization.

**Service**

The final category is the service aspect, which is associated identified problem solution with the service provided by the proposed system (Whitten & Bentley, 2007). In order to address the issues of medical record poor accessibility, the cloud-based provides infrastructure service to host patients’ medical record at an offsite electronic storage location. This provides clinicians with real time data accessibility when they needed. Therefore, it is a feasible and reliable service to manage patients’ medical record.

**Hardware and Software Selection**

Identifying the hardware and software selection to meet the organization’s operational needs is one of the priorities when exploring the informatics solution. The cloud-based medical record provides clinicians with the ability to access patient’s medical record in real-time while provides a cost-effective medical record management solution. The National Institute of Standards and Technology, US Department of Commerce defines cloud network as a model with a shared pool of configurable computing resources which offers rapid information and data exchange with minimal management effort (as cited in Weng et al., 2016). Cloud technology provides information technology capabilities via a network for clinicians in a healthcare organization, which involves a large number of electronic terminals connected through a real-time communication network (Weng et al., 2016). Hence, the implementation of cloud-based solution requires hardware and software selection and utilization.

**Hardware**

The various cloud services include three main categories, Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). SaaS is a basic form of cloud service offers clinicians to operate a software from a remote location; and PaaS provides more on-demand environment for management software applications (Low & Chen, 2012). While considering the organizational requirements and needs, IaaS is the proposed solution. IaaS is a provision model where computer infrastructure is outsourced by an organization to support operations (Low & Chen, 2012). Due to the patient’s medical record storage challenges, IaaS can provide electronic health record storage, hardware, servers and networking services at NOCH.

To virtualize medical record storage into a cloud-based system, an interface and firewall is necessary to link the cloud server with the local electronic terminals at NOCH via internet (Appendix C). Considering the features and benefits of a virtualized cloud-based medical record storage system, the cloud server, firewall, and interface is build and management by Microsoft Azure, no additional hardware is necessary to implement this informatics solution. The clinicians will continue to utilize the existing local electronic terminals to access patients’ medical records storage on the cloud-based system server.

**Software**

By implementing the cloud-based medical record storage solution, clinicians can freely connect to the cloud server to access various patient’s medical record without having to understand or to control the background system. Uploading and downloading patient’s medical information to cloud system in real-time will be the newly added function within the existing EMR system. Patient’s medical record information will be accessed through different EMR modules or be accessed as PDF files within EMR. Therefore, no additional software is necessary to the proposed cloud-based medical record solution.

**Implementation**

Once the project is approved with secured funding, the plan is to implement this project in 28 weeks. The core project team will be consisting of the Chief Information Officer, Chief Technology Officer, Project Manager, Director of Health Record, Program Directors, Clinical Managers and Educators, and Clinical Decision Support. To archive the goal of freely connect to websites to access patient’s medical record in real-time, the System Development Life Cycle (SDLC) is the main implementation strategy utilized for this proposal. According to Rehani (2014), there are many factors alter the successfulness of health information technology implementation in a complex healthcare environment, SDLC is one of the best approaches for health information technology implementation. There are five steps of SDLC, process of planning and requirement definition, analysis, design of the new system, implementation, and post-implementation support (Rehani, 2014). Therefore, the priorities and milestones of the project are (a) understanding the current and future medical record storage process and future system requirement, (b) analyzing the requirement system in solving the identified informatics problem, (c) designing and developing the process of utilizing the new system, (d) implement the proposed solution, and (e) providing post-implementation maintenance and support. The detailed implementation plan and timeline are presented in Appendix D.

Improving the accessibility of patient’s medical record is the impetus for the project being undertaken. Reducing the number of steps and the amount of time spent accessing patient’s medical record are the key information to be disseminated to the organization. The target audiences include the leadership team of NOCH and the Professional Practice Directors and Educators of other acute care organizations, patients and families, other researchers in health care field, and hospital staff. The dissemination methods consist of presentation, information pamphlet, website display, and journal articles in order to facilitate the information translation.

In addition, the project sustainability is an important consideration for the core project team. The cloud service cost $500,000 per year, which will be incorporated into the operational budget of IT Department, which is the most stable support to increase the sustainability of this project. In addition, a policy will be developed to support the use of cloud system. Therefore, the project team is confident that this will be a sustainable project.

**Education Plan**

An education plan has been designed tailored to support the learning and adoption of the newly adopted cloud networking system solution at the hospital. The objectives are to identify the current knowledge and learning needs of the end user, complete end users learning of the cloud system and the developing of super-users. The end users are the multidisciplinary team, largely the nurses at the hospital.

Introduction to the newly adopted system through exposure with marketing throughout the hospital prior to learning further about it can be advantageous in a preparation stage of change to aid in the reduction of resistance as change requires time for adjustment and acceptance (Allen, 2016). Identifying computer literacy and learning needs of the end user can be achieved by survey. Computer literacy and a positive attitude towards the use of a computer system are correlated thus identifying this early can help in identifying end-user willingness to participate in the training of a new system (Gurdas Topkaya & Kaya, 2014).

The education plan is guided by the System Knowledge Assessment Tool and the principles of Training Needs Analysis (Ghazi, Raikundalia, Gogler & Bell, 2011) requiring the identification of roles, knowledge of the user and evaluation leading to a cost effective, personalized and efficient education program. The education plan will be completed prior to the implementation of the cloud solution. The education plan consists of a two-step training and delivered following principles of adult learning (Zemke & Zemke, 1984). The first step is to educate the end users on the newly adopted system with an overview of the system and provide practice time to develop a skill. The second step is to train a group of end users further with frequently asked questions content to support peers with problem solving. These super-users will be able to provide support during the first 6 months after the system goes live, and they will help answer questions and provide on-site support with aims to meet the learning needs of end users after the implementation of the new system (Dimension data, 2015).

The education plan involves a trainer-led teaching format, followed by online simulation case study practice to review information and demonstrate system knowledge and practical skill. This will allow for information recall and transference to their work setting when using the live system (Zemke & Zemke, 1984). The mandatory training is a two-hour session that will be delivered in a classroom setting with a trainer. The training will be offered in 2-hours sessions and will be offered for a period of two weeks consisting of 8-hour days. The trainer will provide a PowerPoint presentation, a trainee ID and access to the system for online simulation use, a user reference guide and a list of frequently asked questions, to support the end user meet their needs related to their work and promote self-direction in their practice (Zemke & Zemke, 1984). At the end of the training, the trainees will be able to provide feedback on the training experience by completing a survey (Ghazi, Raikundalia, Gogler & Bell, 2011). Identified super-users will in addition, have a second session of 4 hours in a classroom with a trainer to gain skills on addressing frequently asked questions and problem solving techniques. This cost-effective approach includes follow up and training of end users by fellow colleague super-users, this approach will contribute to cost savings to the organization (Prosci, 2017). A cost-effective evaluation plan of the training will take place in the training and practice setting with end-user pre-and post-learning surveys (Ghazi, Raikundalia, Gogler & Bell, 2011). In addition, the training team will perform an evaluation of end user knowledge needs by providing them with a survey and collecting feedback from super-users and will attempt to resolve needs arising.

**Evaluation Plan**

For a system to meet the phases of planning, developing and implementing successfully, evaluation will have to take place at every phase (Andargoli, Scheepers, Rajendran & Sohal, 2017). The evaluation for the cloud network will involve open communication with hospital administrators, consultation with end users and administration of surveys (Dimension data, 2015).

The framework of Content, Context, Process (CCP) will provide a holistic approach towards the evaluation of the new adopted system (Stockdale & Standing, 2006). CCP provides the most efficient evaluation method guided by questions (see Appendix E) of who, what, when, where and why, and allowing for evaluation to be completed with a variety of evaluation methods (Andargoli, Scheepers, Rajendran & Sohal, 2017). Two evaluation methods will be used, interview and survey to assess usability, the system’s advantages and disadvantages and adherence to user’s needs (Ahmadian, Saheli Nejad & Khajoei, 2015).

Open communication with administrators and consultation with end users at each phase will provide information that is essential to identify the needs of the client and it sets the tone for ongoing dialogue at each stage of the new system adoption (Dimension data, 2015). Consultation initiates the relationship between the new system and the end user with participation in providing feedback and contributing to decision making, speeding adoption that consequently supports the development of a tailored system that meets the needs of the end user (Prosci, 2017). This evaluation method contributes to cost effectiveness by promoting interest and resulting in easier user adoption and acceptance of the system. In later phases, end users feel then invested to provide feedback and make improvements based on their experience in using the new system (Prosci, 2017). Surveys during the implementation and education phase are administered with the aim to provide information on how the system is meeting the needs of the end user and identify any gaps in the system (Ammenwerth, Graber, Herrmann, Burkle & Konig, 2003).

**Potential Issues and Solutions**

The introduction of change in an organization brings both benefits and potential issues. Cloud networking is a cost-effective informatics solutions that is easy to manage and offers flexibility of resources (Moura & Hutchinson, 2016). The adoption of a cloud based network by the hospital, is based on the goals that aligns with cutting costs of daily transactions and storage, and to provide with consistency in information management of records. In adopting the cloud network as an informatics solution, some potential issues as well as solutions have been identified.

Security of a cloud network can potentially be at risk of being compromised as it could be hacked through application loopholes, an introduction of masked code breaking isolation barriers and a data integrity attack, through the network during data transmission (Moura & Hutchison, 2016). Proposed solutions are the adoption of Intrusion Detection Systems and Intrusion Prevention Systems, both protecting data integrity and data transmission intrusion (Moura & Hutchison, 2016).

Privacy risks is the second issue identified. Privacy bridges can take place when user data is outsourced to the cloud. (Moura & Hutchison, 2016). A proposed solution is a homomorphic encryption and proxy re-encryption scheme. These solutions will prevent data leakage and supports secure query processing over existing encrypted data (Moura & Hutchison, 2016).

Legal issues found in the adoption of a cloud system are related to hosting data on a server in another city or country as it is possible that the local laws of that location provide access to the information. At the same time the hospital may be required by policy or law to store their data at a specific physical location (Ontario, 2013). Possible solutions include following legislative obligations. This can be achieved by the hospital by identifying a privacy officer, and to develop a privacy and security escalation process to assist with addressing incidents and concerns. In addition, the hospital will develop and publish a privacy policy including privacy legislation information. For the province of Ontario, the most relevant legislation is the Personal Health Information Protection Act (PHIPA) (Hassan, 2014).

Ethics in respect to informatics relates to ethical behaviours required from those handling data and information, these are primarily the decision makers, end users and technical support staff. Issues related to ethics can be addressed through an ethics committee and code of ethics to prevent ethical and legal issues (Aluas, 2016). The role of the committee is to analyze ethical dilemmas, and provide advice and educate those involved with complex ethical situations. The committee is guided by the basis of principles and codes of ethics of autonomy, beneficence, non-maleficence, justice and respect as well as the principles of information ethics: respect for information property, respect for privacy, non-maleficence and fair representation (Aluas, 2016). In addition, the code of ethics related for health information professionals on data protection and health information provides ethical guidance, a set of principles against which the conduct of professionals can be measured and to the public, a clear statement of ethical considerations for professionals (Aluas, 2016).

Work-related musculoskeletal disorders are a possible risk for end users involved with the use of poorly designed workstations (Nunes, 2009). In the healthcare setting, paying attention to ergonomic considerations by assessing and identifying ergonomic needs of end users can prevent future expense in rehabilitation, human resources and compensation costs (Nunes, 2009). A solution is the development of an ergonomics program and working along with the existing health and safety committee at the hospital to implement auditing activities and analyze workplaces related to ergonomic risk factors for end users (Hedge, James & Pavlovic-Veselinovic, 2011). The FAST ERGO\_X is a tool that can support the ergonomic auditing activities. This tool (Appendix F) is designed to identify, evaluate and control the risk factors related to ergonomic issues in the workplace, which then provides recommendations to make proper changes and benefit the end users (Nunes, 2009).

**Conclusion**

The cloud network adoption is the most appropriate informatics solution as it addresses the client’s problem by improving on the current system. This is completed in a way that is cost effective and promotes employing existing assets in each of the phases along with the development and implementation team. It is anticipated that cloud networking will meet the needs of the client and their end users holistically.

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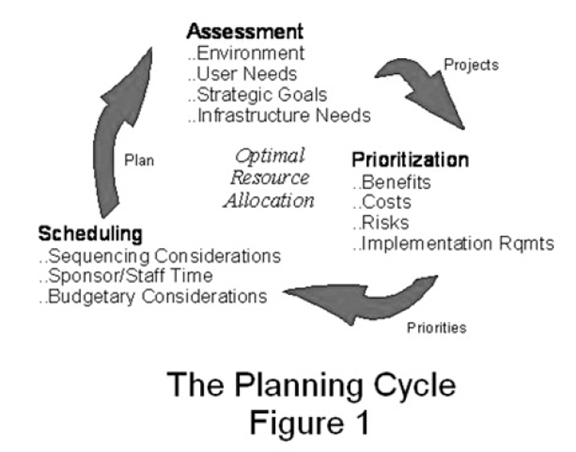
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Appendix A

Johnson’s Planning Cycle



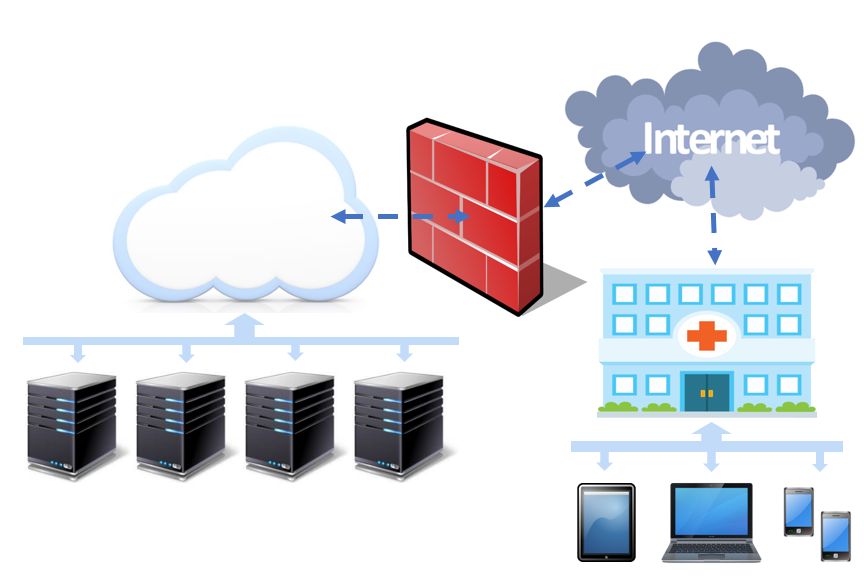
Appendix B

Cost Analysis

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Existing Data Solution**  **(2017-2018)** | **Cloud-based Data Solution**  **(2017-2018)** | **Differences** |
| **EXPENSES:**  Salaries:   * IT Support Technician (2 FTE) * IT Support Specialist (2 FTE) * Clerical Associate, Health Record (5 FTE)   **Total personnel**  Local Servers  Data storage solution  **Total non-personnel**  **Total Expenses** | $86,000  $103,000  $153,000  **$342,000**  $110,500  $790,000  **$900,500**  **$1,242,500** | $86,000  $103,000  $153,000  **$342,000**  $610,000  **$610,000**  **$952,000** | **-$290,500** |

Appendix C

Overall System Architecture



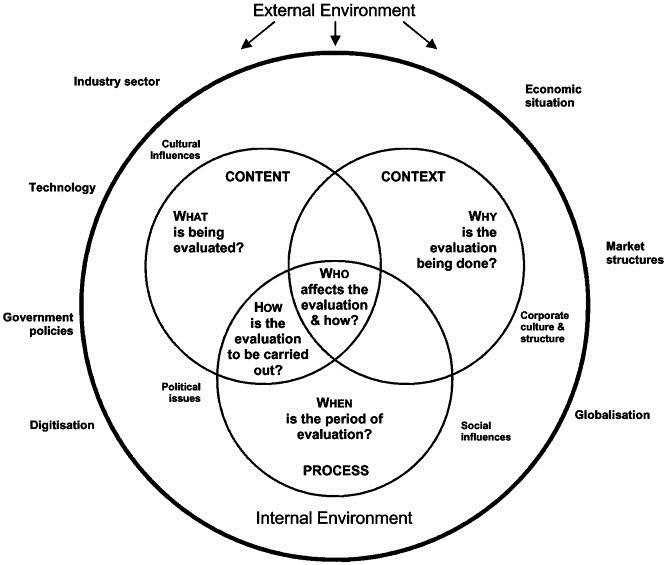
Appendix D

Implementation Plan

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Task and Subtasks** | **Person(s) Responsible** | **Resources Needed** | **Start and Finish Dates** | **Achievement Measures** |
| **Form the core project working group**  **1W** | * Chief Information Officer (CIO) * Chief Technology Officer (CTO) * Program Directors * Clinical Manager and Educator from each clinical program * IS/IT staff * Project Manager (PM) | * Meeting room | September 18, 2017  to  September 22, 2017 | * Core project working group formed * The responsibilities of action items are divided amongst the group members |
| **Review current state of medical record storage**  **1W** | * Director, Health Record * IS/IT * PM * Clinical Managers and Educators | * Meeting room * Office supplies | September 25, 2017  to  September 29, 2017 |  |
| **Decide future states of medical record storage**  **1W** | * Director, Health Record * IS/IT * PM * Clinical Managers and Educators | * Meeting room * Office supplies | October 2, 2017  to  October 6, 2017 |  |
| **Complete system operation requirement to achieve future state**  **1W** | * Director, Health Record * IS/IT * PM * Clinical Managers and Educators | * Meeting room * Office supplies | October 9, 2017  to  October 13, 2017 |  |
| **Submit Request for Proposal (RFP) and vendor evaluation**  **1M** | * CIO * CTO * PM | * Meeting room * RFP | October 16, 2017  to  November 10, 2017 | * RFP signed and submitted by CIO and CTO * Vendor evaluated |
| **Sign service contract with the vendor**  **1W** | * CIO * CTO * Vendor | * Contract | November 13, 2017  to  November 17, 2017 | * Service contract signed with vendor * System interface set up date and service go live date set with vendor |
| **Pre-implementation data collection**  **2W** | * Director, Health Record * Decision Support * IS/IT * PM | * Office supplies | November 20, 2017  to  December 1, 2017 | * Evaluation data collection tool developed * Pre-implementation data collected |
| **Setup interface**  **2W** | * Vender * IS/IT | * Cloud server | November 27, 2017  to  December 8, 2017 | * Interface is built and linked with existing EMR. |
| **Communication to staff**  **5W** | * Core project working group | * Email and poster * Daily huddle * Staff meeting | December 4, 2017  to  December 29, 2017 | * The initiation of this project is communicated to all staff |
| **Book training sessions**  **1W** | * Program Assistants | * Office supplies | December 4, 2017  to  December 8, 2017 | * Training sessions booked by individual program |
| **Develop policy and procedures**  **2W** | * IS/IT * Clinical managers * PM | * Vendor support * Office supplies | December 4, 2017  to  December 15, 2017 | * Cloud system policy and procedures developed and approved |
| **Develop training material**  **2W** | * IS/IT * Clinical Educators | * Vendor support * Office supplies | December 18, 2017  to  December 29, 2017 | * Training Material developed |
| **Training**  **2W** | * Clinical Educators | * Training material | January 2, 2018  to  January 12, 2018 | * Training provided to all clinical staff |
| **Implementation and implementation support**  **2W** | * Core project working group | * Email and poster communication * Daily huddle * Staff meeting | January 15, 2018  to  January 26, 2018 | * Project went live |
| **Post-implementation data collection and project evaluation**  **2W** | * Director, Health Record * Decision Support * IS/IT * PM | * Office supplies | January 29, 2018  to  February 9, 2018 | * Post-implementation data collected * Project evaluated |
| **Post-implementation improvement**  **1W** | * Core project working group | * Email and poster * Office supplies * Staff meeting | February 12, 2018  to  February 16, 2018 | * Project evaluation reviewed * Project improvement opportunities identified * Project improvement strategies implemented |
| **Complete and submit project report**  **2W** | * PM | * Office supplies | February 19, 2018  to  March 2, 2018 | * Implementation data analyzed * Project implementation report completed and submitted to CIO |
| **Dissemination**  **4W** | * PM * Clinical Managers and Educators | * Office supplies | March 5, 2018  to  March 30, 2018 | * Project report and its related information disseminated as outlined in the dissemination plan |

Appendix E

The Content, Context and Process framework



Appendix F

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FAST ERGO X’s inference model. Objective data (measurements) collected in Record Sheets (*recs*) are converted, using inadequacy membership function (*mfunc*), in objective attribute inadequacy degrees (*inato*) and then aggregated into objective risk factor inadequacy degrees (*inrfo*). Similarly, subjective data (opinions) collected in Questionnaires (*quest*) are converted in subjective risk factor inadequacy degrees (*inrfs*), using linguistic variables (*vling*). The next step is to combine objective and subjective risk factor inadequacy degrees in risk factor inadequacy degrees (*inrf*). This risk factor inadequacy degrees are aggregated using weighting factors to evaluate cases inadequacy, which are converted in conclusions using qualification linguistic variables (*vling*(*qual*)). Associated to conclusions are explanations about the results, and recommendations.