PART 1 – FEASIBILITY STUDY IMPLEMENT AN INFORMATION SYSTEM.

Executive summary

Information Systems (IS) and information technology (IT) have changed the current manner in which organizations operate. Through their use, major improvements have been achieved such as: the automation of business processes and the creation of platforms that collect information needed to support the organization's decision-making processes. In addition, through the support of strategic objectives, IS have helped organizations achieve competitive advantages.

Information systems have much to offer in the healthcare industry and can be found in areas such as hospital services and management among others. Hospital information services have also helped simplify many processes such as patient care, clinician appointments, pharmacy, administrative system functions and security (George, 2013).

The Ministry of Health (MOH) of a small island nation is currently facing a problematic situation due the lack of an integrated system for the pharmaceutical services in the island and the lack of automation of some processes such as medication order and prescriptions. The Ministry has established an estimated time of twelve months for both the study of the current problem and the implementation of a viable solution.

Among the outcomes that the Ministry hopes to gain from the implementation of this solution are (1) improved financial management and more efficient use of funds dedicated to the pharmaceutical services, (2) provision of consistent data for evidence-based reporting and decision-support when forecasting pharmaceutical budgets, (3) enhanced productivity, improved patient safety through reduced medication errors and (4) in general, improved operations performance across pharmaceutical health care services in the country.

This document contains a proposed solution for achieving the above mentioned goals or outcomes. It mainly consists of incorporating a pharmaceutical management component into the National Health Information System (NHIS) in order to automate some processes that are currently performed manually. The solution comprises of the integration of new modules in NHIS and also the implementation of a new data architecture (See details in Section 5).

To manage the necessary changes and overcome any risks associated with the integration of the new modules, it is necessary to first analyze the shortcomings and risks of the current system and how these issues can be addressed by the proposed system. This analysis is addressed in Section 4. In addition, the system should be developed in phases allowing for continuous improvements and adjustments based on user feedback when necessary. Finally, a pilot implementation model should be used. This will help work out the bugs or problems before moving to the full implementation.

Section 1: Problem Identification

Antecedents

The Ministry of health of a Caribbean island currently uses an electronic system to manage pharmaceutical services, dispensations and supplies. The system has been implemented in nine polyclinics and one hospital throughout the island. The island currently implements a government subsidized healthcare model where the government provides free healthcare services and pharmaceuticals to citizens for a wide range of non-elective procedures.

The identified problem at the Ministry of Health (MOH) is the inability to amalgamate pharmaceutical services data from the various public health facilities on the island. This is mainly as a result of the lack of an integrate system for the pharmaceutical services in the country. This has severely affected the Ministry's ability to make appropriate decisions regarding the pharmaceutical services offered. As these decisions are to be based on data indicating the amount of drugs or pharmaceuticals dispensed, their cost and frequency of use, the current decentralized and disintegrated pharmaceutical system has not been able to produce timely and accurate results. In addition, the Ministry wants to allow the polyclinics to manage the provision of essential drugs, adding them and easily managing pharmaceuticals from national and international drug suppliers and automatize the process of recording prescription electronically.

Impact on organizational objectives

The Ministry has identified some a number of objectives regarding improving the pharmaceutical service at public healthcare facilities. Some of these objectives are as follows:

- The Ministry is interested in improving quality of care through access to complete patient information from any facility which includes pharmaceutical data.

The current pharmacy system in the polyclinics is outdated and inefficient as each pharmacy has its own database. Therefore, the process of adding or updating new suppliers, drugs must be performed at each polyclinic individually. Also the patient information is fragmented and sometimes duplicated across multiple facilities.

- The Ministry is interested in automating, improving and making processes more efficient to increase productivity.

Actually the medication orders and prescriptions are handwritten. This ordering process itself is a critical step in the patient care process and represents a point where interventions can often prevent medication errors (Wager, Wickham & Glaser, 2013). Automating this process will have a positive impact on the time saved in entering a prescription and also the waiting time of patients for the pharmaceuticals. Also, as a result of the manual ordering process, the actual system is unable to support any clinical decision such as warnings or alerts of drug interactions or contraindications.

In order to enhance productivity, improve patient safety and quality of care medication bar-coding technology should be implemented. “Getting the right drug to the right patient through the right route at the right dose at the right time” (Wager, Wickham & Glaser, 2013).

- The Ministry is interested in improving financial management of resources and performing evidence-based decision making that lead to cost reductions via statistical reports generated from the data captured.

The current system does not allow capturing details of the special programs offered by the government. For example, specialty benefits solutions (SBS) which relieve the patients with certain medical conditions from paying for pharmaceuticals.

Probable solution

A probable solution to the problem identified is the implementation of a Pharmaceutical Management in the national health information system (NHIS). The new Pharmaceutical Management will address the aforementioned problems as follows:

- Polyclinics and clinicians are interested in clinical decision support. Also outcomes and patient safety such as decreasing medication error that can be done in the process of ordering, dispensing or administering medication. This functionality is not provided by the current pharmaceutical system. The NHIS can incorporate clinical provider order entry (CPOE) will adequately address all these objectives.

- The Ministry is interested in better evaluation of the essential public health functions (EPHF) to assess the strengths and weaknesses of the public health system (Pan American Health Organization, 2008). The new solution, which will provide a data synchronization functions that allows to share the data across the facilities and readily accessible data store. The system will support statistical and qualitative reports that can be generated from this data.

- “The Ministry is interested in enhance decision-making, improved data collection, analysis and reporting are all essential to its primary care strategies” (Pan American Health Organization, 2008). A centralized data store will assist in achieving this objective.

- The Ministry is interested in reduce pharmaceutical cost. The NHIS features such as reminders and alerts can reduce pharmaceutical cost prompting the clinician to use generic drugs.

- The Ministry is interested in the service and satisfaction in the healthcare system. The pharmaceutical management will improve the service and satisfaction from the patient’s and the use’s perspective with the fact that the allergies and medications will be available when and where it is needed.

Sections 2 & 3:

Analysis of existing technology

The current technical resources at each pharmacy is as follows:

One workstation or server which houses the main Pharmacy System database and application, five workstations that connect remotely to the Pharmacy System using remote desktop. The current operating system is Microsoft Windows which is required for all the workstations that are accessing the system as well as the server (Fig. 1).

Disadvantages of the current structure

For each workstation that remotely connects or accesses the pharmacy system database, a license has to be paid. Also, only workstations with the Windows operating system must be used for the pharmacy system and house the main database. The Pharmacy System is using FoxPro database, which is outdated and very limited. Although Visual Fox Pro, which constitutes the client interface, is easy to deploy for a small business implementation, it will runs only on Windows and Windows Server operating system environments (Padilla, 2011). This means that a number of user licenses have to be purchased or renewed, increasing operational costs. Additionally, Fox Pro database is harder to secure and old style xBase does not work well on a wide-area network (Fluker, 2001). Therefore, the system presents security risks and sharing information electronically across pharmacies is very difficult which results in a disjointed system. Finally, the FoxPro database presents further challenges. One of these is the number of simultaneous users which is actually presenting some problems when concurrent users are connected.

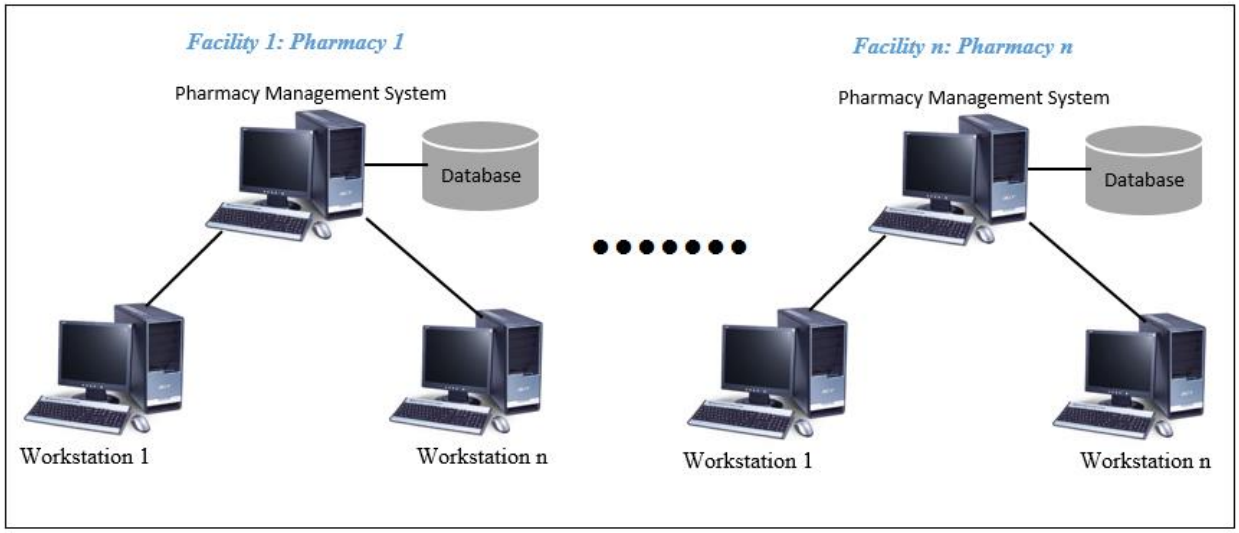

Fig.1: Current layout of the pharmacy system.

Analysis of existing resources

Current resources available:

Outsourcing:

The Ministry of Health (MOH) does not have the financial resources to employ resources in-house. Using outsourcing has lowered operational cost for MOH and increased operational efficiency. Other reasons for the outsourcing decision include the cost of maintaining systems, an ongoing need for system changes and enhancements with associated financial cost (Englebardt & Nelson, 2002).

Knowledge:

The Ministry does not have the adequate human resources to develop and implement IS projects in-house due to a lack of expertise. Therefore, outsourcing allows them to leverage foreign expertise to achieve their objectives. MOH is outsourcing providers from Canada to develop and implement the National Health Information System (NHIS) which includes an advanced Electronic Health Record (EHR). The software is an information system designed to operate the entirety of a nation's health sector. It is comprised of modules that include: electronic health record, admission/discharge/transfer, clinician order entry, laboratory, human resources, public health, and finance. It is a robust system designed to operate in environments with inadequate resources for example poor connectivity, insufficient hardware and low technical skills users. The outsourcing services provided include requirements gathering activities, system architecture, design, programming, testing, integration, training and maintenance.

Requirements gathering activities are done at an early stage in the development cycle. This activities are done in-house due to the fact that it requires close interaction with the customers, users and stakeholders.

Technology:

MOH has provided technical resources such as the hardware infrastructure which include servers, computers and routers among others. This is a core competence that is kept in-house due to the existence of other systems and it can be a risk to allow external providers to access such data and information. The help desk support, system administration and network support department are in charge of the operations and maintenance of the IS hardware.

Testing:

Part of this activity is in-house. Managers and a selected group of doctors are part of some testing activities, such as system testing for control reasons. Also operational acceptance tests (OATs) are done. These tests are carried out to ascertain whether the system is capable of attaining the functional and performance requirements specified. Operational acceptance tests are performed on an isolated test system to avoid conflict with production data. Quality assurance testing is also carried out to check if the system is meeting the specific requirements, while helping to improve the work process and efficiency (Schwalbe, 2014).

Development Initiatives:

Currently there are some modules that are being developed in the National Health Information System such as:

Appointment module: that allows authorized users to schedule events for defined periods and create appointments for any combinations of clinics and clinicians. The module also permits viewing the calendar with the appointments booked for the day, week or month as well as printing out a day's agenda with the appointments booked.

Reports module: as the modules are being implemented, corresponding statistical reports are developed.

Training:

The MOH is outsourcing training sessions. These sessions are scheduled before module deployment or before adding the functionality to the system. Also additional sessions of training are done when required. Manuals and materials are constantly being updated and developed for the training sessions.

Additional Resources needed for the proposed solution

Human Resources

- *System Analyst:* The Systems Analyst role will primarily identify processes that need to be improved. This will mainly consist of analyzing the integration of the SCM and COE modules with the National Health System and their interaction with the SmartStream system.
- *Application support:* Support the technical aspects or components of the system such as installation and configuration of servers, deploying the application and in some instances imparting training to the users.
- *Project Manager:* "An effective project manager is essential for the success of the project" (Schwalbe, 2014). After the feasibility study is completed, the project manager should develop a project plan that will provide details for accomplishing the project goals with their respective initiation and competition dates (Schwalbe, 2014). The project manager will also be in charge of implementing and prioritizing development and creating a budget estimate while working closely with stakeholders and the project team. The overall goal of this resource is to ensure that the development is completed in a timely manner while conforming to the appropriate quality standards outlined for the project deliverables.
- *Trainers:* Training will be conducted to outline the processes that the system supports and the features that the system contains to help the users to perform their jobs. The trainer will supply the necessary material such as user and administrator manuals and documentation that contains the necessary information regarding the system functionality (Schwalbe, 2014). This documentation will serve as a reference once the system has been implemented

Technical resources

- Computers, servers
- Label Printers
- Manuals

Estimated Budget

Suggested budget labor rate of $120/hour for the project manager and $80/hour for each team member, based on working an average of 160 hours per month, full time (Schwalbe, 2014).
Project manager will work part-time, total hours (160/2 * 12) = 960
Project team members works full time, total hours (160* 12) = 1920 (Schwalbe, 2014).

Project Cost Estimate Created July 23, 2015				
Items	**#Units/Hrs.**	**Item Price (Cost/Unit/Hr.)**	**Total**	**Comments**
1.Project Management				
Project manager	**960**	**$120**	**$115,200**	
Project team members	**1920**	**$80**	**$153,600**	
2. Training and Support				
Trainee Cost	**100**	**$500**	**$50,000**	The cost per trainee (100 total) will be $500
Travel Cost	**12**	**$700**	**$8,400**	Travel will cost $700/person and estimate of 12 travel days. Include all pharmacies.
Support				
3. Hardware				
Computers	**36**	**$370**	**13,320**	Four computers needed for each of the 9 pharmacies.
Servers	**1**	**$579**	**$579**	
Label Printer	**27**	**$254**	**$6,858**	Three label printer for each pharmacy
4. Software				
Software development		**$250,000**	**$250,000**	
Total Project Cost			**$597,957**	

Section 4:

Analysis of IS security and risk issues

Introduction

Today companies have become more dependent on information systems (IS). With areas such as data security, communication security, availability and confidentiality becoming increasingly important, securing today's IS has become a very complex task.
Health care information systems contain a large quantity of sensitive data and information. This data can be transmitted between health care organizations by making use of the internet and wide area networks (WANs). Therefore, securing the data within these systems, that support the business processes of healthcare organizations, has become a major concern for organizations and IS professionals. With the objective of ensuring more confidential health care information systems, it is necessary to implement, establish and enforce security policies and procedures to protect this sensitive data.

IS Security and Risk Issues of Current System

The existing pharmaceutical system is a disconnected, distributed information system. Furthermore, the system security risks and issues include:

Out-dated technologies:

Since the system was developed a long time ago it does not make use of latest security technologies encrypt connections and data transfers to and from the application's database. In addition, passwords are stored in plain text in the database. This presents a high risk to confidentiality as plain text passwords are very vulnerable to anyone that can gain access to the database. Furthermore, sniffing programs can easily steal authentication information when that information is being sent from the program to the database as it is sent unencrypted and in plain text.

Difficult user management:

Any one particular pharmacists can work at various public pharmacies. As a result, it is usually necessary to create multiple user accounts for one user at due to the de-centralized nature of the application. This practice is an IS security risk as it makes it difficult for system administrators to determine which user is accessing the system at any time.

Access control/Accessibility:

The user permissions are not very detailed or well defined. That is, user permissions are very broad and lack the necessary granularity required for the various employee roles that exist within the pharmacies.

Risks to data integrity:

The risk of data integrity being compromised is high as the current system requires pharmacists and pharmacy technicians to transcribe prescription data from a written prescription to the system before dispensing. On many occasions where handwriting is illegible, time is lost

trying to decipher the prescription and in some instances patients receive incorrect pharmaceuticals.

De-centralized system:

As the system is de-centralized and geographically dispersed it is very difficult for system administrators to maintain network security components such as firewalls and anti-viruses up to date. Out-dated antivirus software and poorly configured firewalls present elevated security risks to the system.

Backup process is manual:

Since backups are done manually the administrator can forget to do the backup. It is a risk of availability in the case of a disaster.

Proposed System and Relation to Risks and Issues

The feasibility study proposes a distributed yet synchronized system to manage the pharmaceutical services of recording and dispensing prescriptions across the country. The proposed system will also include a supply chain management (SCM) module. Furthermore, the system should interact/share patient's pharmaceutical and clinical history with the national health information system (NHIS).

As information and data availability is very important for pharmacies and clients, securing the data that is contained within the new pharmacy system will be a crucial function (Wager, Wickham & Glaser, 2013). In the new pharmaceutical system the patient pharmaceutical history, the medication order and the prescriptions data will be available among the pharmacies. In addition, as prescription data will come directly from the clinical modules of the NHIS, the risks that are associated data integrity due to transcription of prescription will be reduced.

Another challenge of implementing the new pharmaceutical system will be the visibility of the data. It's important that the system functions can be supported in any type of device, specially tablets, mobiles etc. Also the user interface should be readable and easily visualized because the complexity and amount of data can lead to the user misinterpreting the patient medication orders. Which is a critical step in the patient care process (Wager, Wickham & Glaser, 2013). Therefore to achieve this the system will make use of responsive web technologies.

In order to maintain the security of the information in the new pharmaceutical system, focus can be placed on information technology (IT) security goals. These IT security goals include confidentiality, integrity and availability. As the information will be transmitted across the networks, it is necessary to implement measures to avoid unauthorized access. These methods may consist of:

Transmission and information security:

It will be necessary to implement measures to ensure the information is not modified without detection (Wager, Wickham & Glaser, 2013). To achieve this the system will use encryption for user accessibility and data replication. Secure Sockets Layer (SSL) is the most used technology to provide a secure communication between the web client and the web server. The use of SSL will reduce the risk of accessing authentication data presented by the existing system as this data will not be transmitted in plain text. Another option is to encrypt the data when it is stored on the servers. However, this may increase hardware costs due to the fact that servers with more processing power will need to be obtained to provide acceptable performance.

Integrity:

Data integrity guarantees the accuracy of the information presented from any authorized entity (Alghazzawi, Hasan & Mohamed, 2014). The new system will reduce risks associated to data integrity by ensuring that the accuracy and content of the data has not been compromised or incorrectly transcribed. This is possible as prescribers will enter prescription information in the NHIS from where it will be obtained by the new pharmacy system.

Confidentiality:

Access control measures must be implemented to ensure confidentiality and detect breaches of confidentiality if they occur. These measures may include:

- Authorization: Allowing access to the system only to persons or other software that have been given access rights. This can be achieved through defining a unique identification for each potential user (Wager, Wickham & Glaser, 2013).
- Automatic log-off: The system must implement automated processes that terminate the user session after a determined time of inactivity (Wager, Wickham & Glaser, 2013).

Availability:

Ensuring the availability of the system when required for use. There will not be lack of availability due the replication functionality.

Making data and documents accessible while simultaneously restricting access is part of the security of business operations (Alghazzawi, Hasan & Mohamed, 2014).

Network security:

Network security is critical in protecting the system from any disruptions, threats and patient data. Network security components that can be implemented include: anti-virus, anti-spyware, the software and hardware firewalls (What is network security?, n:d). Firewalls should be well configured to block unauthorized access to the network. Also virtual private networks (VPNs) are an option that can be implemented if secure remote access to the system is required.

Section 5:

Proposed solution and recommendations

Description of the proposed solution:

A proposed solution for the Ministry of health (MOH) is to enhance the capabilities of the National Health Information System (NHIS) that is being implemented, adding some modules such as:

- **Supply Chain Management (SCM)** module that will track the inventory at stores throughout all connected facilities and help manage the movement of inventory from one store to another. The consumption of inventory (through dispensing), disposal of inventory and manual stock level adjustments are also recorded. The SCM module will provide transparency of stock levels throughout the system. Also, it will facilitate, track

and record the movement of inventory from one store to another, disposal of inventory and manual stock level adjustments.

- **Clinician order entry (COE)** module that will allow recording and viewing prescriptions electronically and creating electronic dispensing records. The prescriptions will be attached to a patient's health record so that authorized users can view the patient's prescription and dispensation history.

The solution of implementing and adding these two modules in the NHIS will allow the Ministry to have a wide range of functionality integrated into one system. The SCM and COE modules will closely interact with each other. Each time a configured pharmaceutical is dispensed, the SCM module will automatically adjust the stock in the store from which the item(s) originated. Furthermore, clinicians will be able to view the stock levels of pharmaceuticals at pharmacies allowing them to prescribe readily attainable drugs.

The Ministry is also interested in improving the quality of patient care. Adding these two modules to the NHIS will have a positive impact on the health care of patients using government health care services. Also, the electronic prescription process will add efficiency and increase staff productivity. These modules will also allow for the generation statistical reports that are expected to positively impact the financial management of resources and permit evidence-based decision making using the data captured that will lead to cost reductions.

Furthermore, the implementation of these modules will increase the efficiency and productivity. The SCM module will be integrated with the medication orders and prescription processes that will be automated. It will reduce the waiting time of patients for pharmaceuticals as there will be no need to re-enter information for each system. Also, integrating these modules brings a technological change and integrated business processes at the polyclinics that increase the business value (Turban & Volonino, 2011).

Network Architecture:

Part of the solution is the implementation of data/network architecture.

Data synchronization function:

This function consists of implementing database synchronization technology which supports multiple master replication. That is, it supports bi-directional, asynchronous data replication and the replication data will be scheduled or near real-time operation (Long, 2015). Thus, the information entered at multiple pharmacies will be simultaneously replicated to all other pharmacies. The database synchronization technology used is also resilient to network outages. The new proposed modules will use these advanced data replication functions to reliably and accurately transfer data site-to-site in a timely manner over a wide area network that suffers intermittent periods of no connectivity. The recommended technology is Apache ActiveMQ.

The replication function will allow every pharmacy at each facility in the entire island to share the patient information, history of the prescriptions record prior to dispensing the drugs. Also, the replication function will make the NHIS system more efficient in the process of adding or updating new suppliers and drugs due to the administrative overhead and maintenance that this requires. Data synchronization will help address the inefficiencies of the existing operational

processes across the facilities such as eliminating the need to enter the same data multiple times in different systems.

A further advantage of the data replication function is that it will will increase the scalability, performance and fault-tolerance of the whole system (Jimenez & Martinez, 2009). Fault-tolerance is demonstrated when the failure of the wide area network does not stop users from doing their jobs as the databases at the affected pharmacies will resume synchronization when connectivity is restored. Scalability can be achieved by distributing the load across all replicas. Finally, database replication can provide fast local access, even if clients are geographically distributed clients, if data copies are located close to clients (Jimenez & Martinez, 2009).

Network Architecture:

Background

This proposed network architecture will give the system the capacity to handle pharmacy servers or nodes within an unreliable network environment where poor connectivity between the facilities exist. Furthermore, the system will be able to operate across low-bandwidth connections and withstand periods of network outage (Long, 2015). This architecture is composed of a number of servers. This includes a Master data store which controls how and when data is replicated throughout the system, a Message Broker which serves as the postmaster or postman of the system being responsible for synchronizing the data between the Master data store and the pharmacy server databases. The proposed network scheme is shown below (Fig. 2).

Fig. 2: Network architecture of proposed solution.

Alternative Solution

Currently, the polyclinics and hospitals are running many different systems across multiple departments such as a pharmaceutical system, inventory system, financial system and electronic medical record (EMR) software. These systems are incompatible because the same data is re-entered in different databases and also through various system interfaces which produces inefficiencies. Also, due to the disconnection between the pharmaceutical system and National Health Information System (NHIS) there is a duplication of effort that increases the probability of human error (Turban & Volonino, 2011).

Another possible solution discussed was the implementation of an Enterprise Resource Planning (ERP) system. However, there are some factors that may impede the implementation of such a system. One such factor is that ERP implementations are complex and the process is usually very costly. Therefore, it is necessary to hire a consultant or project manager that fully understands the current business processes that may need to be re-engineered and re-designed (Burns, 2013). Another factor that may impede the ERP implementation is the need of continued support from senior management in taking decisions and giving the necessary time for the implementation's success. As government agencies are notorious for being politically motivated, gaining senior management support can be difficult if the ERP implementation does not coincide with political goals. As a result this can negatively affect user and institutional adoption resulting in project failure.

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