INCORPORATING BUSINESS PROCESS MANAGEMENT, BUSINESS ONTOLOGY AND BUSINESS ARCHITECTURE IN MEDICATION MANAGEMENT QUALITY

by

Bonnie Sue Urquhart

M.Sc., University of Montreal, 2009

THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY
IN
HEALTH SCIENCE

UNIVERSITY OF NORTHERN BRITISH COLUMBIA

SEPTEMBER 2018

Abstract

Managers and care providers in the health sector are expected to deliver safe, efficient and effective services within a resource constrained, complex system. Services are provided through execution of multiple processes. Healthcare organizations tend to be structured in functional based silos with process improvement efforts often focused on individual processes within the discrete silos. This silo based improvement approach fails to take into account upstream and downstream processes executed and managed in other silos. A patient's journey will typically include processes from multiple silos and therefore, improvement efforts need to focus on end-to-end processes if the goal is to deliver a positive patient experience. In order to optimize processes in a complex adaptive system like healthcare and to effect meaningful change a combination of management disciplines is required. This research explored the use of Business Process Management (BPM), Business Architecture (BA) and Business Process Management Ontology (BPMO) as a comprehensive, integrated approach to design, redesign, evaluate, improve and monitor the safety, efficiency and effectiveness of medication management processes in a multi-site healthcare organization.

The contribution of the research was threefold. First, identified benefits of applying BPM, BPMO and BA to increase organization capacity and improve the end-to-end process of medication management; second, demonstrated the application of an ontology and the business layer of enterprise architecture used in other sectors could be successfully utilized in the healthcare sector; and third, developed a process reference model for medication management processes in acute care and long term care facilities.

Keywords: Business Process Management, Business Architecture, Business Ontology, Medication Management, Quality Improvement

Acknowledgements

Successful completion of my PhD was not a solo journey. There were numerous people along the way who provided support, mentorship, guidance and love. I am extremely grateful to each and every person who participated in this journey and enabled my success. Some have been with me for the entire journey and others have been there only briefly or intermittently but all deserved to be acknowledged.

Thank you to my supervisor and committee members, Dr. Waqar Haque, Dr. Henry Harder, Dr. Balbinder Deo and Dr. Craig Mitton for your patience, encouragement and your commitment to helping me achieve this milestone.

I would like to thank Prof. Mark von Rosing from Global University Alliance. His knowledge in my field of study and his willingness to share that knowledge has certainly enriched my journey.

A special thank you to colleagues at Northern Health who actively participated in the research and gave up their time to attend workshops, working groups and interviews. Your willingness to join me on this journey was very much appreciated. I would especially like to acknowledge the members of my team at Northern Health who have worked beside me in this pursuit.

Words cannot begin to express my appreciation to my husband, Ken Urquhart, my children, Kimberley and Keith Payne along with my entire family who have always believed in me and given me strength to pursue my dreams.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

ADE	Adverse Drug Event
AHP	Analytical Hierarchy Process
APQC	American Productivity and Quality Council
BA	Business Architecture
BIZBOK	Business Architecture Guild of the Objects Management Group
BO	Business Ontology
BPE	Business Process Engineering
BPM	Business Process Management
BPMH	Best Possible Medication History
BPMN	Business Process Management Notation
BPMO	Business Process Management Ontology
BPMS	Business Process Management System
BPO	Business Process Orientation
BPR	Business Process Reengineering
CFHI	Canadian Foundation for Healthcare Improvement
CHSRF	Canadian Health Service Research Foundation
CIHI	Canadian Institute for Health Information
cpKPIs	Clinical Pharmacy Key Performance Indicators
CRNBC	College of Registered Nurses of British Columbia
CSF	Critical Success Factor
EA	Enterprise Architecture
FEAF	The US Federal Architectural Framework
FNHA	First Nations Health Authority
KPI	Key Performance Indicator
LEAD	Layered Enterprise Architecture Development
MDWG	Multidisciplinary Working Group
MIS	Management Information System
MSQC	Medication Safety & Quality Committee
MWG	Measurement Working Group
NH	Northern Health
OMG	Objects Management Group
PBMA	Program Budgeting and Marginal Analysis
PHSA	Provincial Heath Service Authority
PPI	Process Performance Indicator
PSLS	Patient Safety Learning System
PWG	Prioritization Working Group
ROP	Required Organizational Practice
SBO	Strategic Business Objective
TOGAF	The Open Group Architectural Framework
WMS	Workload Management System

1 Introduction

1.1 Background

Healthcare organizations face challenges delivering services which are safe, effective, efficient, reliable and compliant with legislation, regulations and standards. Healthcare providers are expected to provide high quality, patient centered care while meeting growing demands, changing technologies and constrained resources. A specific area of concern is the incidence of adverse drug events (ADEs) that are the result of medication errors in prescribing, dispensing, administering, documenting or inpatient monitoring. The medication process spans multiple functional units and involves a number of different clinicians and allied healthcare workers. The functional units include acute care inpatient wards (surgery, paediatrics, maternity, etc.), emergency rooms, ambulatory care units, operating rooms, long term care facilities, harm reduction units, and community services. People involved in the process include prescribers (usually a physician), clinical pharmacists, dispensary pharmacists, pharmacy technicians, supply chain staff, and point of care staff including Registered Nurses, Licensed Practical Nurses and specially trained Care Aides. Healthcare services and prescription medications are highly regulated and clinicians themselves are responsible for adhering to the regulations and standards set out by their licensing bodies. The number of people involved, the need to comply with relevant regulation, legislation, and standards, combined with the high degree of potential harm to patients and competing demands being placed on clinicians contribute to the complexity of the medication management processes. In addition to patient safety, there is also a need to consider worker safety and the increasing costs of pharmaceuticals when designing processes. The problems with medication management have been well documented (Baker, et al., 2004 & Keers, Williams, Cooke, Walsh & Ashcroft, 2014); however, no single standardized way of

addressing the problem has been identified. This research is an attempt to identify a systematic approach to deal with patient safety and quality issues within medication management that could be used in other healthcare service areas.

Business Process Management (BPM) has been described as a key enabler for the analysis and improvement of health care processes (Antonacci, et al., 2016); however, it has not yet been widely adopted within healthcare organizations (Mertens, Gailly, & Poels, 2015). This research explored the use of BPM and the introduction of a Business Process Management Ontology (BPMO) and Business Architecture (BA) as a comprehensive management approach to improve the quality of medication management processes within a healthcare organization. In this research it is proposed that high quality medication management processes would need to meet the following five objectives: 1) Safe (eliminate or at least reduce medication errors & adverse drug events), 2) Effective (produce desired results), 3) Efficient (minimum resources and time), 4) Compliant (meet standards, guidelines and legislation), and 5) Reliable (minimal variation in outcomes). These five objectives were derived through discussion with working group members and review of host organization quality improvement efforts specific to pharmacy and medication management prior to this research. In addition to improving the quality of medication management processes within the organization, the perceived challenges and benefits of this management approach were also explored from the perspective of those involved in the improvement efforts and the organization's leaders.

1.2 Thesis Outline

There are five chapters included in this thesis: 1) Introduction, 2) Literature Review, 3) Methodology, 4) Results and 5) Discussion and Conclusion.

Chapter 1, the current chapter, establishes and sets the foundation for this research. This chapter includes background of the problem being studied, the research objectives and rationale for the research. This chapter includes terminology and definitions used in the thesis along with the approach that was used in the research. It also provides the context of the host organization and concludes with the contributions made to the body of knowledge on Adverse Drug Events and the use of BPM, BPMO and BA in the healthcare sector.

Chapter 2 provides a Literature Review which covers six topic areas. These topics and the identified relationships represent all the components that formed the basis of the thesis. Figure 1 provides a visual representation of these topics and their relationships. The relationships shown within the figure were derived by looking at the overarching goal of high quality medication management and then determining how each of the research topics contributed directly or indirectly to achieving that goal.

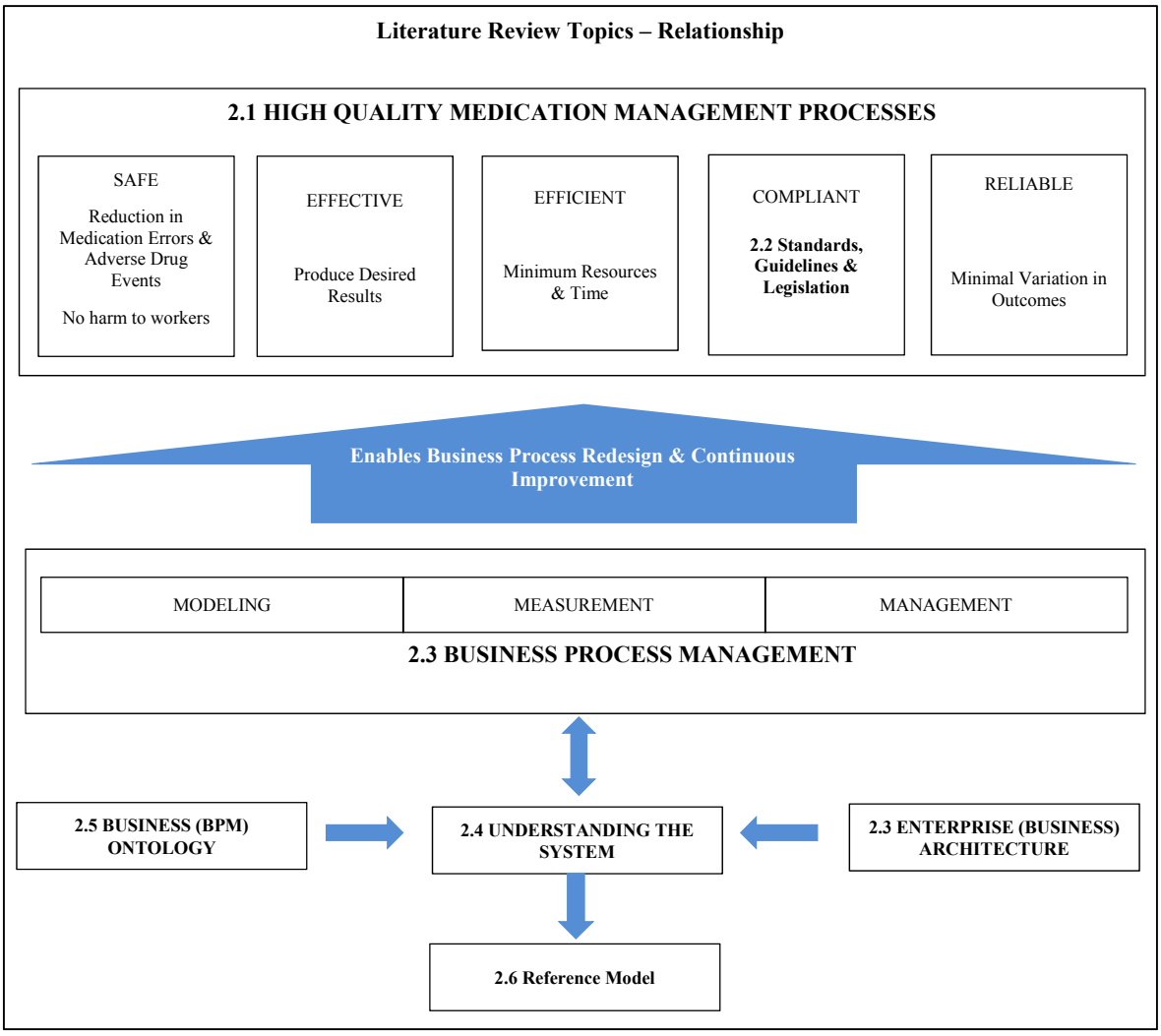


Figure 1. Literature Review Topics & Relationships

Chapter 3 describes the research methodology (mixed methodology) which included both quantitative and qualitative methods. This chapter also describes the procedures and tools used in this research.

Chapter 4 describes the results of the research. A total of 7 business artefacts were developed during the research. These are: 1) strategy map, 2) strategy canvas, 3) business competency model, 4) value chain, 5) strategic action plan, 6) prioritized list of improvement initiatives and 7) performance monitoring plan. Semi-structured interviews with workshop participants and organizational leaders were recorded, transcribed and analyzed. Analytical

Hierarchy Process (AHP) was used to prioritize the list of improvement initiatives. A proposed process reference model for medication management was developed including processes categorized as core (main), support and management processes in acute care and long term care facilities.

Finally, chapter 5 summarizes contribution and limitations of the research, in addition to potential future research topics arising from this work.

1.3 Research Objectives

There were three objectives of this research. The first objective was to determine the impact of introducing BPM, BPMO and BA to improve medication management quality in a publicly-funded health care organization. The second objective was to explore the perceived challenges and benefits of using BPM, BPMO, and BA in a healthcare organization. The third and most enduring objective was to create a process reference model for medication management which could potentially be adopted by other healthcare organizations interested in applying BPM to improve medication management processes within their organization.

The information required to meet the first objective included domain information specific to medication management service such as current 'as is' process and proposed improved or 'to be' process along with how the quality of the service would be measured. The information required to meet the second objective included qualitative information from the process participants to determine what they perceived were the impact, if any, of using the comprehensive management approach. This information was gathered from the workshop participants and organizational leaders through semi structured interview questions. The information required to meet the third objective required the development of appropriate business artefacts that provided specific information and definition of business objects. Examples of business artefacts were strategy map, strategy canvas, process models,

and business competency models. Examples of the business objects were: business competencies, organizational areas and the process groups for medication management service within the host organization. Business artefacts include business objects and these were used in this research to develop consensus and increase participants' understanding of medication management end-to-end processes within the context of the host organization.

The three objectives were explored from the perspective of the following five research questions.

1) How can a Business Process Management Ontology used in other industries be effectively applied to healthcare services?
2) What processes should be included in a process reference model for Medication Management applicable to hospitals and long term care facilities?
3) What performance measurements in addition to medication errors are appropriate for monitoring and controlling Medication Management?
4) How can BPM be effectively applied to a situation that involves multiple sites and multiple business units responsible for Medication Management functions?
5) What are the benefits and challenges of using BPM, BA and BPMO to improve Medication Management?

The relationship between the three research objectives and the five research questions is provided in Table 1.

Table 1 Research Objectives & Questions

Objective	**Research questions**
Objective 1 - determine the impact of introducing BPM, BPMO and BA to improve the quality of medication management in a publicly-funded health care organization.	• Question 3 • Question 4

Objective 2 - explore the perceived challenges and benefits of using BPM, BPMO, and BA in a healthcare organization	• Question 1 • Question 5
Objective 3 - create a process reference model for medication management	• Question 2

The relationship between research objectives, research questions and data collected is provided in Table 2.

Table 2 Relationship between Objectives and Data Collection

Objective	**Data Collected and Analyzed to Answer Related Research Questions**
Objective 1	• Question 3 Performance measures • Question 4 Business Artefacts based on systems approach and utilization of Business Architecture principles also example provided of how BPM was applied to a single business process within medication management.
Objective 2	• Question 1 As demonstrated by using a comprehensive approach that included the business ontology along with BPM and BA • Question 5 Thematic and summative content analysis of participant and leaders interviews
Objective 3	• Question 2 Processes included in Process Reference Model developed based on business artefacts

1.4 Rationale for Research

The need to improve delivery of health care services has been well documented in literature and often discussed in the public forum. There is a belief that quality and patient safety within current services could be improved and costs could be contained (Canadian Foundation for Healthcare Improvement, 2011).

Patient safety and specifically adverse events related to medication errors continue to be a major concern in the health care sector. Medication errors are one of the most common reported adverse events, it has been estimated that 7.5% of patients admitted to Canadian hospitals in 2000 experienced an adverse event (Baker, et al., 2004). A subsequent study of a single hospital in Ontario in 2003 detected 4.4 adverse drug events per 100 patient days (Forester, Halil, & Tierney, 2004). A systematic review of adverse drug events among adult

inpatients showed a range of 3.6% to 60.7% reported in 28 published articles between January 2000 and June 2013 (Martins, Giordani, & Rozenfeld , 2014). Adverse events cause harm to patients and tragically in some instances lead to permanent injury or death. There is also additional cost to the healthcare system as adverse events result in extended length of stay or readmission to acute care facilities. The medication management process involves many people including patients, nurses, physicians, pharmacists, pharmacy technicians, and pharmaceutical companies. The quality of the information used in the medication management process and the effectiveness of the translation of this information are key to reducing adverse events.

It has been demonstrated that several healthcare organizations have successfully transformed their organizations by focusing on quality improvement resulting in better service at lower cost (Canadian Foundation for Healthcare Improvement, 2011). These organizations operated from a systems perspective, remained committed to quality improvement and used information as a critical platform for guiding improvement, measuring results and monitoring performance. This study reported on outcomes but did not provide any specifics as to the management approach taken, nor the methods for identifying and prioritizing process improvement initiatives. Taking a systems view of the organization requires an understanding of the end-to-end processes that deliver the value in the system. BPM focuses on end-to-end processes. It is a management discipline that integrates the quality improvement principles of Deming and Shewart with the business process reengineering approach promoted by Hammer and Champy (Hammer, 2010).

This research explored the impact of using BPM to develop a process model for medication management within a regional health authority serving a geographically dispersed population. BPM has been described as including: management of business processes,

measurement of business processes and modeling of business processes (Bandara, Chand, Chircu, Hintringer, & Karagiannis, 2010). This research included all three elements and resulted in identification of appropriate measures, a comprehensive process model and recommendations on management of the processes.

It is important to understand why medication errors occur and how they can be avoided or detected before any harm is caused. High quality medication management processes would be safe, effective, efficient, compliant and reliable. Zero medication errors may not be a realistic expectation due to the complexity of healthcare; however, it is feasible to mitigate the likelihood or severity of medication errors. Contributing to the complexity of the medication management processes are the numerous clinicians and technicians involved in the process and the multitude of standards, guidelines and legislative requirements applicable to prescription medications. As described in Section 2.1 adverse drug events most often occur in the Prescribing step or the Medication Administration step in the end-to-end medication process. The causes of these errors can be categorized as people issues (lapse of attention or negligence on the part of an individual) or system issues (systemic issues such as unnecessary complexity in process, poor communication and inadequate information systems).

BPM has evolved from the three process traditions of 1) management tradition, 2) quality control tradition and 3) information technology tradition (Harmon, 2014). BPM requires the process for medication management be explored within the context of the system it is operating in. This requires an understanding and comprehension of 'systems thinking' as it relates to an organization.

The BPM lifecycle consists of six phases: 1) process identification, 2) process discovery, 3) process analysis, 4) process redesign, 5) process implementation and 6) process

monitoring and controlling (Dumas, La Rosa, Mendling, & Reijers, 2013). The process identification and process discovery phases when combined with a clear understanding of the system will provide the necessary information to develop a process architecture (Dumas et al., 2013)

There are a number of domains involved in the medication management process including the medical domain, information technology domain, information management domain and the business domain. Each domain has its own unique vocabulary and indeed the clinicians and professionals within each of the domains often do not share the same language which can be problematic to successful execution of the process. A shared vocabulary or common language would increase understanding and decrease confusion when documenting processes and objects within the medication management process. The introduction and use of a BPMO would provide a common language and the means for illustrating the relationship between objects within the processes themselves or between other objects within the organization. Enterprise Architecture (EA) provides a structure for the objects within the organization. Examples of objects in a complete EA include: software application, network server, business area, process owner, strategic business objective, and critical success factor. The objects included in this research can be found in the business layer of the Enterprise Architecture and therefore are referred to as Business Architecture (BA) throughout this dissertation.

Healthcare and healthcare organizations are complex and disciplines such as BPM, BPMO and BA have the potential to reduce the level of complexity and create a shared understanding of medication management safety across the organization.

1.5 Terminology and Definitions

This section includes definitions and terminology used throughout this document and is intended to provide clarification on how terms were applied in this specific research.

Medication errors have been defined by the National Coordinating Council for Medication Error Reporting and Prevention (NCCMERP) as:

> "*A medication error is any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient, or consumer. Such events may be related to professional practice, health care products, procedure, and systems, including prescribing, order, communication, product labeling, packaging, and nomenclature, compounding, dispensing, distribution, administration, education, monitoring and use."* (National Coordinating Council for Medication Error Reporting and Prevention, 2017).

Adverse events have been defined as "*adverse events are unintended injuries or complications resulting in death, disability or prolonged hospital stay that arise from health care management*" (Baker, et al., 2004, p. 1678). Medication errors that lead to an adverse event are referred to as Adverse Drug Events (ADEs).

Process has been defined as "*a collection of interrelated tasks and activities that are initiated in response to an event which aims to achieve a specific result for the consumer of the process"* (von Rosing, Scheer, & von Scheel, 2014, p. 1). Customers can be external or internal to the organization and from the perspective of publicly funded health services external customers are synonymous with clients, patients & consumers.

Over the last ten years the definition of BPM has evolved from being narrowly defined at the individual business process level to being defined as spanning organizational

and system boundaries. The focus of most definitions of BPM, however, is on process improvement of end-to-end core business processes. It has been defined narrowly by Khan as "*BPM is a methodology for modeling, automating, managing and optimizing a business process through its lifecycle to increase profitability*" (Khan, 2004). The BPM Institute defines BPM as *"the definition, improvement and management of a firm's end-to-end enterprise business processes in order to achieve three outcomes crucial to a performance-based, customer –driven firm: 1) clarity on strategic direction, 2) alignment of the firm's resources and 3) increased discipline in daily operations"* (Business Process Management Institute, 2016).

Swenson and von Rosing (2015) undertook a review of over 100 articles that included definitions of BPM. They have proposed the following definition that suggests BPM is to take a 'systems thinking approach' to process management.

> "*Business process management (BPM) is a discipline involving any combination of modeling, automation, execution, control, measurement, and optimization of business activity flows in applicable combination to support enterprise goals, spanning organizational and system boundaries, and involving employees, customers, and partners within and beyond the enterprise boundaries"* (Swenson & von Rosing, 2015, p. 87).

It would appear then that BPM could be used to improve a single end-to-end process or used at a system level to transform and improve an entire organization. This would be determined by which of the myriad of BPM definitions that a practitioner subscribes to. For the purposes of this research, the definition offered by Swenson and von Rosing above will be applied. The medication management process includes many actors and influencers, some within the organization but many external to the organization including pharmaceutical

suppliers, professional standard setting organizations and legislative bodies. The need to view the end-to-end process including drivers and influencers beyond the enterprise boundaries is also consistent with the more comprehensive definition of BPM.

BA is defined as "*A blueprint of the enterprise that provides a common understanding of the organization and is used to align strategic objectives and tactical demands."* (Business Architecture Guild, 2017, p. 1). BA and BPM are two separate but closely related disciplines. BA is a component of EA. EA has been defined as "*a set of concepts and practices based on holistic systems thinking, principles of shared language, and the long-standing disciplines of engineering and architecture*" (Kappelman & Zachman, 2013, p. 87).

Ontology has been defined as a "*formal, explicit, specification of a shared conceptualization*" (Gruber, 1993, p. 199). It has also been defined generally as "*a representation of the entities in reality and the relations between those entities* (Blobel, Goossen, & Brochhausen, 2014, p. 58). A more comprehensive definition is "*An ontology is an artefact, more precisely an intentional semantic structure that encodes the set of objects and terms that are presumed to exist in some area of interest (i.e. the universe of discourse or semantic domain), the relationships that hold among them and the implicit rules constraining the structure of this (piece of) reality"* (Giaretta & Guarino, 1995, p. 314).

1.6 Approach

This research employed a mixed methods approach incorporating both quantitative design and qualitative design. Quantitative design consisted of the use of Analytical Hierarchy Process (AHP) to rank improvement opportunities while performance data was collected based on a repeated measures design and analyzed using statistical process control charts. Qualitative design included workshops and semi-structured interviews.

The scheduling of workshops and working group meetings was highly dependent on availability of participants. Three half day workshops were held over an eight week period. The invitation to attend was sent to twenty- six individuals recommended by the Chair of NH Medication Management Safety and Quality Committee. This group included representatives from management staff of all areas included in the end to end process for medication management in the organization. The first workshop was attended by twenty-two of the twenty-six individuals who had been invited. The second workshop included fourteen of the original twenty-two attendees and the third workshop included thirteen of the original twenty-two attendees. The workshops consisted of an introduction to BPM, strategy maps, business competency models and value chains along with discussion and consensus on what should be included on the medication management business artefacts. At the conclusion of the workshops two smaller working groups were formed to work on the prioritization of improvement opportunities and the development of a performance measurement plan for medication management in the host organization. These working groups met monthly for five months which was followed by another meeting to finalize the work. The duration of each meeting was from one to three hours for a total of twelve hours for the prioritization working group and eleven hours for the measurement working group. The final results from these working groups were then provided to workshop participants

Two separate sets of semi-structured interviews were also conducted. The first set of interviews was with individuals who had participated in the medication management workshops and working groups. These individuals were selected by the Medication Safety & Quality Committee of the host organization based on their role within medication management processes. Those identified provided a reasonable representation of the various clinicians and support staff knowledgeable in medication management issues. It was

determined that they constituted a reasonable sample of individuals with responsibility for medication management. The criteria for inclusion was that individuals had to have participated in at least one of the workshops. Exclusion criteria was any individual who had participated in the workshop that had a reporting relationship with the researcher in her supervisory role within the host organization. In total, twenty individuals were invited to participate in these interviews and eleven (55%) individuals were interviewed. This group had a view on the entire process of development of business artefacts, identification of performance measures, identification of improvement initiatives and prioritization of those initiatives using AHP. This put them in a unique position to comment on the benefits and challenges of the comprehensive management approach.

The second set of interviews was with individuals in senior leadership roles within the host organization. A senior leadership role was defined as a member of the Executive Team or a staff member reporting directly to a member of the Executive Team. This group encompassed strategic management roles across all business areas and geographic locations of the host organization. The only direct report staff who were excluded were individuals in administrative assistant roles. In total, seventy-three individuals were invited to participate and twenty-one (29%) agreed to be interviewed. This group had exposure to the business artefacts across all portfolios and represented those responsible for strategic planning across the organization. Thus, they provided a valuable perspective on the challenges and benefits from an organization wide perspective.

The transcribed interviews were analyzed using thematic and summative content analysis. The following six themes were identified: Capacity Building, Communication, Collaboration, Competing Priorities, Culture and Connection to Strategy. The summative content analysis of the transcribed interviews was completed to shed light on differences and

similarities in language used by respondents as they described the benefits and challenges of using BPM, BPMO and BA related to medication management.

1.7 Context of Host Organization

In the province of British Columbia, Canada there are two population based health authorities and five geographic health authorities. The Provincial Health Services Authority (PHSA) provides tertiary services province wide including cancer care, renal services, ambulance services, transplant services, pediatrics, and high risk pregnancy services among others. The First Nations Health Authority (FNHA) has a mandate to support the health and wellness of First Nations people in BC. Northern Health (NH) is one of the five geographic health authorities responsible for providing the full spectrum of publicly funded health care services from health promotion and protection through to acute care and end of life care.

NH provides health services to a population of approximately three hundred thousand people spread across six hundred thousand square kilometers in northern British Columbia, Canada with service provided in mainly rural and remote communities. Acute care and diagnostic services are provided in eighteen hospitals and nine diagnostic and treatment centres. Long term complex care residential services are provided in thirteen standalone facilities and ten of the eighteen hospitals have beds allocated to long term complex care.

Medication management processes in acute and complex care facilities are of concern to the organization as evidenced in internal documentation that includes medication management as one of its eight strategic action plans in its 2016/17 to 2018/19 Operational Plan. Medication error events were the second highest reported event in the Patient Safety Learning System (PSLS) of the host organization in the fiscal year ended March 31, 2017. This was second only to reported safety events related to in-facility falls. The PSLS is a voluntary reporting system where clinicians and health workers can report events related to

patient safety. Between April 1, 2016 and March 31, 2017 there were a total of twelve thousand, three hundred and sixty five safety events reported and three thousand, two hundred and fifty (26.28%) of these were medication safety events. The events reported included situations where no harm came to the patient, and the more serious events where there was harm to a patient. Since this is a voluntary reporting system it is reasonable to conclude that not all reports of medication errors are being reported.

Publicly funded Canadian healthcare organizations, including Northern Health, report financial cost based on a standard Management Information System (MIS). The Canadian Institute for Health Information (CIHI) maintains the standards for the general ledger chart of accounts which is the basis of the financial and statistical general ledgers used in publicly funded Canadian healthcare organizations.

Priority setting and resource allocation within NH is a challenge with requests for resources, both financial and human, exceeding the resources available (Urquhart, Mitton, & Peacock, 2008). Medication management processes and drug costs are a material portion of the annual operating expenses. Unfortunately, physician and nursing costs specific to medication management processes are not available due to the lack of an activity based costing system or workload measurement system within NH. Pharmacy and drug costs are available and the annual cost in 2016/2017 was in excess of eighteen million dollars. In addition to the financial costs, recruitment and retention of clinicians, particularly pharmacists to a rural setting is an ongoing challenge for NH.

The organization was in the early stages of introducing BPM and BA when the research commenced with the medication management initiative being the first to officially adopt this management approach. During the research period an additional organizational

BPM initiative was undertaken to address concerns in home based services related to aging of the population and growing demand for home based services.

1.8 Contribution

Healthcare has been slow to fully adopt BPM despite the success demonstrated in other sectors. This has been largely attributed to the dynamic, flexible, knowledge intensive processes within healthcare (Mertens et al., 2015). This research combines BPMO and BA with BPM to demonstrate a holistic and comprehensive management approach to improve medication safety and quality within acute care and long term care facilities. Although this research does not solve all the problems related to complexity of the healthcare system, it provides a repeatable approach to demystifying the connection between strategies aimed at patient safety and the underlying processes in need of redesign. Further, this research included a thematic analysis of healthcare leader's perceived benefits and challenges of using BPM, BPMO and BA, as well as, development of a process reference model for medication management. The reference model could be used by other healthcare organizations interested in introducing BPM to improve quality of medication management services within their organization.

2 Literature Review

The medication management process spans organizational boundaries, involves numerous healthcare professionals, results in high costs, and is governed by a multitude of standards, guidelines and legislative requirements. Achieving sustainable improvements in such a complex process requires an understanding of the process itself and the context in which the process is executed. The literature review explored what is currently known about medication errors and how management disciplines such as BPM, BPMO and BA could be employed to create a high quality medication management process. The literature review includes six areas: 1) medication errors and adverse drug events, 2) standards, guidelines and legislative requirements, 3) BPM, 4) viewing the healthcare organization as a system, 5) BPMO, and 6) reference models.

2.1 Medication Errors and Adverse Drug Events

Quality concerns related to medication errors and adverse events occurring in hospitals and long term care facilities continue to be a subject of interest. Medication errors can happen anywhere in the medication management process and as a result of rigorous checks and balances these errors are often caught before they impact the patient. Adverse drug events occur when the administration of medication results in an unexpected or unwanted reaction in a patient. An adverse drug event could be the result of an undetected medication error or a drug reaction that could not have been known in advance (such as an allergy not known to the patient or an unusual side effect of a medication).

Reported statistics from a United States study showed 39% of medication errors were the result of inaccurate ordering by physicians, and almost half of those errors were intercepted by nurses or pharmacists before the medication was administered to the patient. Meanwhile 38% of errors occurred during medication administration, generally by nurses,

and only 2% of those were intercepted (Leape, et al., 1995). It is important to understand where in the process errors occur and also the possible root causes of the errors. This knowledge is essential in order to select appropriate and sustainable improvement efforts that will have positive impact on lowering the number of adverse drug events as well as mitigating the degree of harm to the patient. The remaining 23% of medication errors occurred in one of the following steps in the medication management process: dispensing, documenting or monitoring. It was also reported that nurses intercepted 86% of medication errors and pharmacists intercepted 12% (Leape, et al., 1995).

A Canadian study of adverse events showed that, in the fiscal year 2000, for every 100 patients admitted to an acute care hospital, 7.5 patients experienced at least one adverse event. Drug or fluid-related services accounted for the second highest incidence of adverse events at 23.61% just below surgical service at 34% (Baker, et al., 2004). The 7.5% of patients who experience one or more adverse events reported in this study are similar to a UK study (Vincent, Neale, & Woloshynowych, 2001), lower than studies in New Zealand 12.9% and Australia 16.6% (Wilson, et al., 1995) and higher than two large US studies 3.7% (Brennan, et al., 1991) and 2.9% (Thomas, et al., 2000). These studies did not all use the same selection criteria and the US study had focused on finding negligence while the other studies focused on quality improvement and preventability of adverse events. The authors of the Canadian study concluded that 58% of all adverse events found were attributed to either medication safety or surgical services; therefore, efforts to improve these two services would have considerable positive impact on reducing adverse events in Canadian hospitals (Baker, et al., 2004).

There are numerous articles that report on the causes of medication errors in acute and long term care facilities with a focus on the medication administration step in the process

(Chircu et al., 2013; Elliott & Liu, 2010; Keers et al. 2014; Poon, et al., 2010; Keers et al. 2013). A systematic review of fifty-four articles relating to causes of medication administration errors in hospitals was conducted and the authors categorized the causes into the following three levels based on Reason's model of accident causation: 1) High Level Strategy, 2) Error/Violation Provoking Conditions and 3) Unsafe Acts and Omissions (Keers, et al., 2014; Reason, 2000). Included in the High Level Strategy category were management decisions, organization policies, economic & regulatory context, safety agenda, and clinical negligence schemes. The Error/Violation Provoking Conditions category included: training and experience, patient factors, errors in medicines supply, physical/mental health, inadequate procedures, poor communication, poor supervision, heavy workload, staffing/skill mix, unsuitable environment, and local working culture. The Unsafe Acts and Omissions category included: memory lapses, action slips/failures, knowledge and rule based mistakes and violations (Keers et al., 2014).

There were several themes that arose in the review of the literature related to medication errors, and adverse drug events. These themes are also evident in the information provided by the various accrediting bodies and organizations focused on patient safety and quality of healthcare. The collection of "best possible medication history" and the importance of medication reconciliation upon admission and at time of transfer or discharge is a repeating theme. The "five rights" of medication administration is taught to all nursing students and is expected to be a standard of practice (Right patient, Right drug, Right time, Right dose and Right route). Over time the traditional five rights of medication administration have been expanded to nine rights including Right documentation, Right action, Right form and Right response (Elliott & Liu, 2010). Northern Health's internal policy document on Medication Administration includes a tenth right which is the Right of

the client to refuse medication when deemed capable to do so. An interesting point is the CRNBC practice standard on medication administration includes seven rights. It does not refer to Right action, Right form or Right of client to refuse medication (College of Registered Nurses of British Columbia, 2016). Most often the nurse is the last line of defence in preventing medication errors and it therefore stands to reason that supporting nurses by providing appropriate information and adequate time to execute evidence informed processes in medication administration could reduce medication errors (Chircu et al., 2013).

Communication of information among healthcare providers and between patients and healthcare providers has also been identified in the literature as an area that requires further study. Liu, Manias & Gerdtz (2011) explored and contrasted six conceptual models to determine how to improve medication safety practices. The six models include two causal models and four exploratory models. The two causal models are Human Error Model and System Analysis Model. The four exploratory models are Shared Decision-Making Model, Medication Decision-Making and Management Model, Partnership Model and Medication Communication Model. They concluded that the Medication Communication Model was the most insightful (Liu, Manias, & Gerdtz, 2011). The model identified antecedents and defined attributes of actual communication encounters and consequences when tested in an Australian hospital (Manias, 2010). The application of standard procedures and conceptual models in healthcare settings are challenging due to diversity of the setting and various players within the setting (Liu, Manias, & Gerdtz, 2011).

The Human Error Model was used in a systematic review of medication administration errors to categorize the causes of errors. The authors concluded that interventions to reduce medication errors should focus on system factors versus person factors (Almaney, 1974; Keers, Williams, Cooke, & Ashcroft, 2013) . A medication

communication framework was developed using the Circle of Care Modeling approach. This work led the authors to identify that there is a Coordinating step in addition to the other five steps of Determine Need, Prescribe, Dispense, Administer and Monitor that they had initially anticipated (Kitson, Price, Lau, & Showler, 2013)

Addressing medication errors could be approached from either a person or a systems perspective. The Person Approach to addressing medication errors would focus on the person identified as responsible for creating the error such as the physician, pharmacist, nurse or technician. This traditional approach assumes there was some lapse of attention or negligence on the part of an individual resulting in the occurrence of the error. The underlying assumption in this model is that the 'safe' process was not followed. Conversely, the System Approach to medication errors assumes there are systemic factors which cause errors and the focus of addressing errors should not be directed at individuals but at the system in which individuals work (Reason, 2000). The National Coordinating Council for Medication Error Reporting and Prevention balances both these perspectives in its publication 'Reducing Medication Errors Associated with At-risk Behaviours by Healthcare Professionals'. This document suggests that healthcare providers are willing to take risks which could result in patient harm because the risk to the patient seems remote and the at-risk behaviour may save time or be more convenient for the provider. They attribute the at-risk behaviours to unnecessary complexity in processes and an organizational culture which tolerates and often rewards at-risk behaviours (National Coordinating Council for Medication Error Reporting and Prevention, 2017).

A soft systems approach would appear appropriate in addressing a process such as medication management where there is a high reliance on individual clinicians following a dynamic process that spans organizational functional boundaries. Siriam (2012) proposes

BPM which combines soft systems methodology (qualitative) with hard systems methodology (quantitative). The author suggests that involving people early in the process will lead to a higher level of success and demonstrates how to engage people through a case study of an information technology service, using a combination of developing "rich pictures" and using Analytical Hierarchy Process (AHP) to identify the most critical processes for improvement efforts. The rich pictures were developed during workshops with extensive consultation with individuals involved in the service area which was followed by applying a hard systems approach of using the AHP methodology to numerically quantify and rank the options (Siriam, 2012).

A conceptual process map for the medication management process of a hospital inpatient stay or long term care resident stay may include the following steps: 1) Registration, 2) Patient Assessment 3) Prescribing including Medication Ordering, 4) Dispensing, 5) Administering including Documenting, 6) Monitoring and 7) Discharge. This process reflects the steps as linear when in reality there could be many iterations within the process as medications are changed or orders are clarified. These steps do not include the supporting processes or management processes such as inventory management, quality assurance, drug formulary management or the multitude of other activities that support a high quality medication management process. A review of eight articles that have incorporated information related to a conceptual process map for medication management show a range with a minimum of five steps to a maximum of sixteen steps (Bell, Cretin, Marken, & Landman, 2004; Bell, et al., 2007; Bepko, Moore, & Coleman, 2009; Chircu, Gogan, Boss, & Baxter, 2013; Classen & Metzger, 2003; Uberoi & Sibal, 2008; Qian & Yu, 2013; Redley & Botti, 2013; Uberoi & Sibal, 2008; Verrue, et al., 2011). The article documenting the sixteen steps was a case study focused on the information quality which would explain the

granularity and why the number of steps were higher than the other articles reviewed (Chircu et al., 2013). The remaining articles contained either five, six or seven steps and interestingly, registration was not a step in any of the articles. This is a crucial step in the process as all subsequent steps rely on the accuracy of the registration information, particularly the information related to any "known" allergies. The four steps included in all eight of the examples were prescribe, order (transmit), dispense and administer. Not all processes reviewed included a monitoring step or a documentation step however, both monitoring and documentation are assumed to be included as part of the Administer step. Documentation occurs immediately following the administration of medication and monitoring is an ongoing activity of nursing care.

Information technology is purported to be one of the solutions to address medication safety issues (Bell et al., 2004; Bepko et al. 2009; Beuscart-Zephir et al., 2010; Chen & Tsai, 2014; Classen & Metzger, 2003; Keers et al., 2014; Keohane, et al., 2008; Pham, et al., 2012; Poon, et al., 2010). Electronic medication management systems, closed-loop bar coding for medication administration, automated medication dispensing cabinets, computerized practitioner order entry, as well as data collection and reporting systems that can provide real time information to support clinicians in decision making have been shown to reduce medication errors (Bepko et al., 2009; Keers et al., 2014).

Measurement of medication safety in real time is a key to reducing medication errors and "surveillance" is the appropriate term to use when considering the reasons for the measurement. Physicians and pharmacist could benefit by having easy and timely access to clinical information, such as most recent lab results, when prescribing or reviewing medication therapy. Real time clinical data could assist the physician in prescribing the most appropriate medication or dosage level. Likewise, it could assist the pharmacist as they

double check appropriateness of the prescription (Classen & Metzger, 2003). Automated medication dispensing cabinets and closed loop bar coding systems provide clinicians with valuable information and a secondary check at time of medication administration (Pham, et al., 2012; Poon, et al., 2010). Automatic alerts can be programmed into medication infusion pumps which alert a nurse when the dosage being administered is outside normal range and this would trigger a second check by the nurse before the medication is administered to the patient.

The prescribing phase of the medication management process has been identified as one of the more error prone phases. Electronic prescribing shows great promise in reducing the errors at this phase of the process (Bell et al., 2004). Legibility is an issue with manual prescribing as are transcribing errors and completeness of information. Electronic prescribing eliminates the legibility issue as all prescriptions would be entered into the computer system by the prescriber. Transcription errors could be reduced by the electronic transfer of data. Electronic prescribing also provides clinicians with drug information, patient history, drug formulary information and medical records at time of prescribing.

The implementation of information technology within healthcare can be extremely challenging and a Human Factors Engineering approach is recommended. This approach is similar to BPM in that one of the first steps is to analyze the work system. The authors found very few standardized processes in healthcare which made it difficult to introduce the technology in a way that lead to efficient and effective workflows (Beuscart-Zephir et al., 2010). A study in Ireland looked at a failed attempt to implement a human resources and payroll software application for nation-wide healthcare services. The failure was attributed to the difficulty in implementing a single system in a non-standardized environment (Helfert, 2009).

The introduction of technology may reduce certain types of errors but complexity of the software applications and end-user knowledge could result in the introduction of new types of errors in the process (Redley & Botti, 2013). This does not mean that new technology should not be introduced but that it is necessary to fully understand the processes and relationships so users of the software applications are capable and prepared to use the new technology effectively. BPM's focus on the processes within an organization reveals opportunities to use information technology to automate steps within the process. This allows clinicians to have access to real time information for clinical decision making thereby increasing the opportunity for the correct decision to be made and avoid errors. BA provides the context in which the processes are being executed thereby increasing the understanding of processes included in specific business areas. It also identifies information systems, data stores and infrastructure which supports the processes.

Identifying and quantifying medical errors and adverse drug events has relied on voluntary reporting by clinicians, or on the use of chart reviews or 'triggers' for non-voluntary reporting (Classen & Metzger, 2003). In addition to these two methods six other approaches were identified in the literature. These include: 1) review of claims data, 2) patient monitoring, 3) administrative data examination, 4) direct care observation, 5) computer monitoring and 6) incident reporting of sentinel events (Montesi & Lechi, 2009).

Quality improvement efforts by National Health Services (NHS) in the United Kingdom (UK) have led to the design, development and implementation of a 'Medication Safety Thermometer' (Rostami, et al., 2017). This approach to improve safety requires data on harm and potential harm related to medication be collected one day per month and the data is then used to inform and monitor efforts to improve medication safety. This approach combines direct care observation, patient monitoring and chart review. Claims data focuses

on review of litigation information and incident reporting sentinel events only addresses the most serious errors where obvious harm has occurred to the patient. The examination of administrative data is limited due to its retroactive perspective and the absence of clinical data.

Computer monitoring refers to the use of clinical information systems to harvest electronic data relevant to medication errors and adverse drug events which has the potential to provide real time data that could prevent medication errors. Major limitations of computer monitoring are inserted errors, poor software, poor triggers and undetermined future risks (Montesi & Lechi, 2009). In addition, there are very high costs to purchase, implement and maintain clinical information systems.

The Patient Safety Learning System (PSLS) is a software program used in all British Columbia health authorities. Care providers are expected to voluntarily report all adverse events or "near misses" within that software application. Reported incidents are then followed up by management to determine the remedial action required to prevent these or similar incidents from happening again in the future. Data from the PSLS is analysed by risk managers to determine where specific organizational improvement efforts are required to improve overall patient safety. The expectation is for all events to be recorded; however, there has been some resistance by healthcare providers to report incidents in fear of blame or repercussions. It is suspected within the host organization that the information recorded and available for "no harm" incidents is underreported. There is slightly more confidence in the information reporting of incidents causing moderate to significant harm as these incidents typically require some escalated medical response as well as discussions with another clinician or supervisor. A study found several issues with the underreporting of adverse drug events when voluntary reporting was used. The results revealed only three incident reports

had been filed in the same period that case finding showed fifty-four adverse drug events had occurred (Cullen, et al., 1995). A systematic review of literature related to the causes for underreporting of adverse drug events by health professionals indicated similar results. The review included twenty-nine articles from seventeen different countries published between 1992 and 2012. Causes of underreporting were categorized in seven attitudes: 1) complacency, 2) fear of litigation, 3) guilt, 4) ambition or financial benefit, 5) ignorance on when or how to report, 6) insecurity and 7) indifference. These have been labelled as the seven deadly sins of adverse drug events underreporting (Inman, 1976). The authors of the article concluded there should be an eighth deadly sin added, the lack of training in pharmacovigilance for health professionals (Varallo, Guimaraes, Abjaude, & Mastroianni, 2014).

2.2 Standards, Guidelines and Legislative Requirements

There are numerous standards, guidelines, industry practices and legislative requirements that need to be considered in the development of an end-to-end process map for medication management. Healthcare professionals are registered with their respective colleges and are expected to meet the standards and ethical conduct set out by their governing bodies. Physicians, pharmacists and nurses all require a licence to practice their profession; for example, Nurse Practitioners and Registered Nurses practicing in British Columbia are required to be members of the College of Registered Nurses of British Columbia (CRNBC) and both have Professional Standards and Practice Standards they must adhere to. There are four Professional Standards and seventeen Practice Standards documented on the CRNBC website. Three of the seventeen Practice Standards are specifically related to the medication management process. These Practice Standards are Dispensing Medication, Medication Administration and Medication Inventory Management (College of Registered Nurses of

British Columbia, 2015). The CRNBC website also references sixty-seven separate pieces of legislation including provincial and federal legislation that are relevant to Nurses' practice (College of Registered Nurses of British Columbia, 2014). The four specific pieces of legislation related to medication management are: *Controlled Drugs and Substances Act* (Federal), *Hospital Act, Pharmaceutical Services Act* and *Pharmacy Operations and Drug Scheduling Act*. Physicians, Pharmacist, Licenced Practical Nurses and Certified Pharmacy Technicians also have standards and legislation guiding their work and influencing how they must perform their duties. These standards and legislative requirements need to be considered in development of a comprehensive process model for medication management. In addition to the individual professional responsibilities to meet standards and legislation, the health care organization is also subject to legislation and standards. The organization must also operate within the confines of the government mandated practices. Most health care organizations in Canada also voluntarily participate in Accreditation Programs, the conditions of which must also be considered when developing a comprehensive process model for medication management.

Accreditation Canada classifies required organization practices (ROPs) in six major categories: Safety Culture, Communication, Medication Use, Work life /Workforce, Infection Control, and Risk Assessment. The purpose of the required organizational practices is to help guide the provision of safe, high quality health care (Accreditation Canada, 2015). NH is accredited and is committed to meeting these ROPs. The activities within the comprehensive medication management process model will need to comply with the ROPs. An example of one of the ROPs in Medication Use category is the requirement to obtain a best possible medication history (BPMH) and complete a medication reconciliation

upon admission to hospital or long term care facility, and before and after transfers between and within facilities.

Compliance with standards, guidelines and legislative requirements must be built into the medication management processes. This can be a challenging task as there is often conflicting goals between business and control objectives (Sadiq, Governatori, & Naimiri, 2007). The comprehensive management approach of using BPM, BPMO and BA in the process modeling and process improvement could help facilitate the development of process models that incorporate business rules and business objects related to compliance.

2.3 Business Process Management

Academics and practitioners have both contributed to the literature on BPM. Practitioners have contributed a multitude of articles and books providing case studies, frameworks and "how to" guides of BPM. There has been far less publications in academic journals on the "why" of BPM (Smart, Maddern, & Maull, 2009; Trkman, 2010). The result has been that most articles have been atheoretical (Melao & Pidd, 2000). Despite the imbalance there has been progress in addressing the need to identify the theories underpinning BPM (Biazzo, 2002; Lacerda, Cassel, & Rodrigues, 2010; Niehaves, Poeppelbuss, Plattfaut, & Becker, 2014; Trkman, 2010; Trkman, 2013). The five theories proposed as relevant to BPM are socio-technical theory, theory of constraints, dynamic capability theory, contingency theory, and task-technology fit theory. Socio-technical theory, theory of constraints, and dynamic capabilities theory are proposed as being able to singularly explain the 'why' of BPM. Alternatively, a combination of contingency theory, dynamic capability theory and task-technology fit theory are used to explain the why of BPM.

1. The socio-technical theory referenced by (Biazzo, 2002) and (Xiang, Archer, & Detlor, 2014) highlighted that for BPM to be successful both technical aspects (the techniques, tools and methods used) and the socio aspects (attitudes and beliefs of people) need to be considered in implementation of a design or redesign process.
2. The limitations of the performance of an organizational system were explored through the use of the thinking process which is derived from the theory of constraints and attempts to determine 'why' things happen versus 'how' they happen (Lacerda et al., 2010).
3. The dynamic capabilities theory refers to an organization's ability to change rapidly in response to changes in the external or internal environment. This is crucial for an organization that wants to maintain a competitive advantage. If implemented appropriately, BPM could be considered as a dynamic capability (Niehaves, Plattfaut, & Becker, 2010; Niehaveset al., 2014).
4. Contingency theory, dynamic capability theory and task-technology fit theory when taken together provide a theoretical base for BPM (Trkman, 2010). Trkman was able to draw logical and substantiated alignment between the critical success factors of BPM and each of the theories. The author further explored this alignment in 2013 when looking at critical processes that must be in place within a BPM focused organization (Trkman, 2013).

There is a lack of an agreed upon theoretical base for BPM. Practitioners have taken the lead in publishing which has resulted in a proliferation of articles espousing best practice. There is an assumption that these best practices are transferrable. This is not necessarily true because the design of the service process is driven by contextual factors (Ponsignon, Smart,

& Maull, 2012). The existing literature is consistent in understanding of the evolution of BPM and referencing business re-engineering and workflow management approaches. It has been expressed that BPM might be considered as simply the repackaging of old ideas that enabled consultants and management gurus to promote their approaches as novel (Trkman, 2013).

BPM has evolved from three business process traditions (Harmon, 2014). These are: 1) management tradition, 2) the quality control tradition, and 3) the information technology tradition as shown in Figure 2.

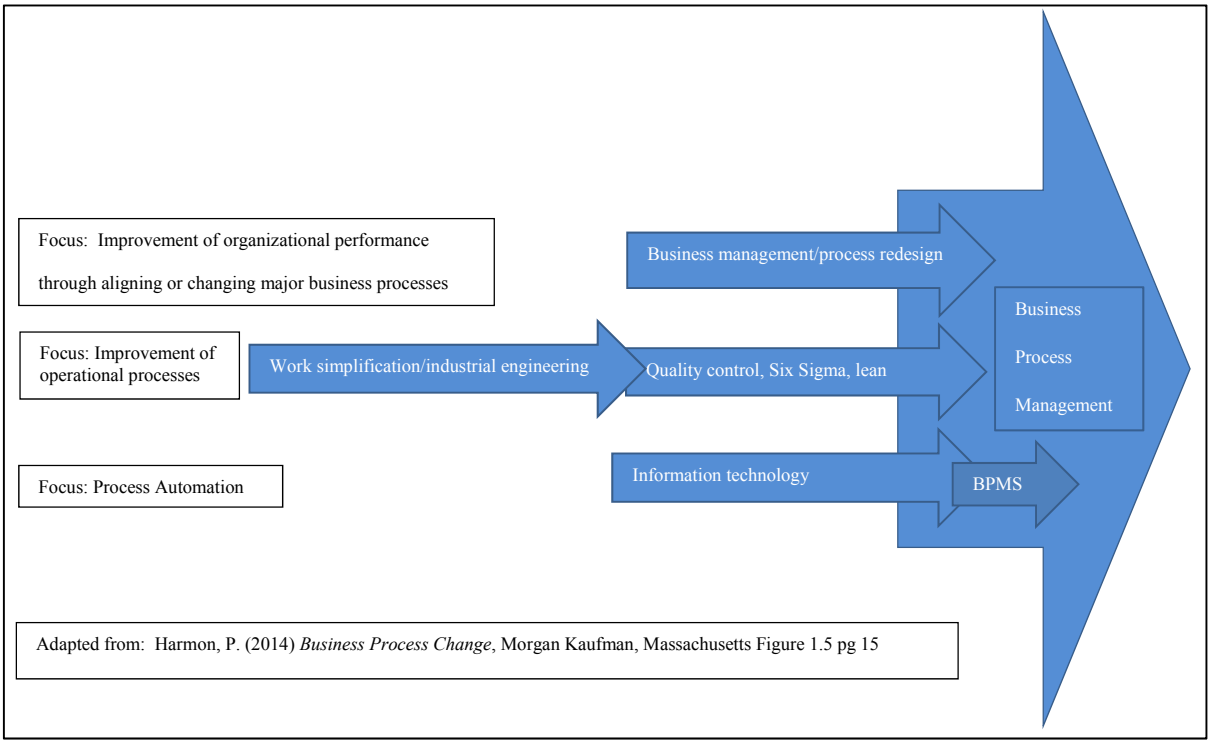


Figure 2. Evolution of BPM

The management tradition focuses on overall performance of an organization and examples of contributions to BPM include the findings of Porter's Value Chain, Kaplan & Norton's Balanced Scorecard, Process Frameworks, Business Process Engineering and Business Process Reengineering. (Harmon, 2014; Margherita, 2014; von Rosing et al., 2014).

The quality control tradition has focused on the quality and production including contributions such as, Total Quality Management, Six Sigma, Lean, Lean Six Sigma and Capability Maturity Models. Notable contributors in this field include Shewart, Deming, Juran, Ohno and Womack (Harmon, 2014; Margherita, 2014; von Rosing et al., 2014).

The information technology tradition has enabled the automation of work processes and examples of contributions from this tradition include IT Architectures, Structured Software Methodologies, CASE tools, Business Process Modeling Tools, Expert Systems, and Business Process Management Notation (BPMN). Notable names in this tradition comprise of Martin, Davenport, Hammer, Champy, Gartner, and Object Management Group (Harmon, 2014).

Business Process Engineering (BPE) and Business Process Reengineering (BPR) are both business management strategies that focus on the design or redesign of processes for the purpose of creating maximum value for an organization. This approach to process improvement has been attributed to Hammer and Champy (Harmon, 2014). The quality improvement approach proposed and popularized by Shewhart and Deming focused on using statistical process control to reduce variation in individual processes and supported continuous quality improvement through monitoring of processes via ongoing measurement (Hammer, 2010). The process engineering and reengineering approach focuses on end-to-end processes which is an improvement over the approach to quality process improvement proposed by Shewhart and Deming. The primary criticism of the Shewhart and Deming approach was that it defined process very narrowly as any activity which included an input, activity steps and an output. The result of this general definition is that an organization could have thousands of processes. Quality improvement activities that look at individual processes outside the context of the end-to-end process could yield improvements in one

process but create inefficiency in either upstream or downstream processes. BPE and BPR were an improvement to these approaches as they examined the entire process from the perspective of producing value for the customer. However, BPE and BPR are perceived as episodic or radical approaches with a less disciplined approach to performance measurement and continuous process improvement (Hammer, 2010; Niehaves et al., 2010; Looy, Backer, & Poels, 2014). BPM combines the strengths of both approaches to quality improvement and also incorporates the use of information technology. BPM is more consistent with a systems perspective because it takes into account the interrelationships between the processes being designed or redesigned and other processes, rules and requirements within the system. The business process management software applications (BPMS) available in the market have led to confusion in the interpretation of what BPM actually is. It is not a software program but rather a management discipline that can be facilitated through the use of technology and software applications (Palmer, et al., 2014).

Standardization of processes and process automation are a desired outcome of most BPM projects (Harmon, 2014). Standardization and automation of processes can result in technical efficiency and has shown to have a positive impact on process time, cost and quality (Munstermann, Eckhardt, & Weitzel, 2010). Lack of standardization and manual processes tend to be more expensive and result in unintended variances in both cost and quality of services (Langley, et al., 2009). Process automation using technology is a common means of creating an efficient and effective process. It has been shown that hospitals with a high degree of process orientation are more efficient than the ones without such process orientation (Vera & Kuntz, 2007).

Measuring quality improvement requires measures be collected on the performance or output of the service as well as measures such as time and cost (Davenport & Beers, 1995).

These measures of both output and process enables an organization to overcome the over reliance on financial measures only to measure their performance. The development of process based management information and the ability to incorporate this with financial management information increases management knowledge of the functioning of the entire organization and assists in the identification of opportunities for improvement. It also facilitates an organization to develop a balanced scorecard.

The balanced scorecard approach to performance management requires performance measures be balanced among four perspectives: 1) financial, 2) customer/market, 3) process capability, and 4) learning/growth (Kaplan & Norton, 1992). The performance measures of the medication management process should include measures from all four of these perspectives. Financial measures report on the financial results and include such performance measures as return on investment or operating margin. Customer/market measures include market share and customer satisfaction. Process capability measures include cost, time to market and quality. Learning/growth measures include employee engagement and availability of systems ((Kaplan & Norton, 1992). These four perspectives or quadrants developed for business use can be appropriately adapted to a publicly funded health care organization. The financial quadrant focuses on the stewardship of public funding with the measures being expense variance to budget and annual capital cost allowance of equipment compared to annual investment in new equipment. Customer/market measures can be adapted to represent Service Excellence measured by patient and family satisfaction with services and compliance with legislation or government mandates. Process capability refers to internal processes and appropriate healthcare system measures can include clinical outcomes such as hospital readmission rates and hospital mortality rates. Learning and growth is the perspective on staff and physicians' ability to maintain

professional learning and appropriate measures can include employee engagement and access to training and education.

Development of safety indicators for medication use was undertaken by a group of twenty national experts in Canada (Nigam, et al., 2008). Table 3 shows a listing of these indicators. The indicators all relate to error rate except 16, 17 and 18 which refer to cycle time or wait time.

Table 3. Safety Indicators for Medication Use

1. Frequency of potentially dangerous medication abbreviations
2. Frequency of potentially dangerous dose abbreviations
3. Frequency of ambiguous prescription dosing instructions
4. Frequency of incorrect prescription dose designations
5. Dosing for pediatric medications that have a narrow therapeutic index
6. Documentation of allergy status
7. Administering protocols for high-alert prescription medications
8. Verification of high-alert prescriptions
9. Machine-readable coding systems for administration
10. Rate of Adverse drug event (ADE)- related hospitalizations
11. Rate of ADE-related ER visits
12. Monitoring and reducing ADEs by assigning pharmacists on rounds
13. Differentiation of high-alert prescription medications
14. Medication histories for inpatients with complex high-risk regimens
15. Medication reconciliation rate
16. Medication reconciliation rate upon admission
17. Medication reconciliation rate prior to discharge
18. Timeliness of discharge medication summary sent to community physicians
19. Discharge medication summaries sent to community physicians (rate)*
20. Safety of compounding sterile medications

**Note item 19 is an interpretation for the safety indicator as the published article showed the same description for both 18 and 19 (Source Nigam et al., 2008)*

In addition to the safety indicators noted in Table 3, eight clinical pharmacy key performance indicators (cpKPIs) have been reported in the literature (Fernandes, et al., 2015). Using a modified Delphi approach with a group of clinical pharmacists across Canada they reached consensus on eight cpKPIs Table 4. These cpKPIs are specific to clinical pharmacists working within the hospital setting and have overlap with the Safety indicators for Medication Use noted in Table 3. The processes associated with these cpKPIs reflect how the work of clinical pharmacists contributes to the reduction of medication errors and adverse drug events.

Table 4. Clinical Pharmacist Key Performance Indicators

1. Proportion of patients who receive formal documented discharge medication reconciliation and resolution of identified discrepancies by a pharmacist
2. Number (or proportion of patients who receive formal documented admission medication reconciliation by a pharmacist (includes a pharmacist best-possible medication history or pharmacist best-possible medication history review as part of the medication reconciliation process as well as resolution of identified discrepancies)
3. Number (or proportion) of pharmacists who actively participate in interprofessional patient care rounds to improve medication management
4. Number (proportion) of patients for whom clinical pharmacists have completed (executed/implemented) a pharmaceutical care plan
5. Number of total drug therapy problems resolved by pharmacists
6. Number (or proportion) of patients receiving proactive comprehensive direct patient care by a pharmacist in collaboration with the health care team
7. Number (or proportion) of hospital patients who receive medication counseling by a pharmacist at discharge
8. Number (or proportion) of Patients who have received in-person education from a pharmacist about their disease(s) and medication(s) during their hospital stay

Adapted from (Fernandes et al., 2015)

The quality of medication management processes can be measured by the number and frequency of medication errors. There are numerous participants in medication management processes who transfer information between each other either verbally, electronically or on paper. The transfer of patients and related information between clinicians or functional (business) units is referred to as "handoffs". These handoffs can result in errors and unnecessary duplication of effort due to incomplete or inaccurate information flows between the siloed business units (Gemmel, Vamdaele, & Tambeur, 2008). It has been found that the information quality during handoffs can and often does lead to medication errors. Using BPM combined with accounting control theory these researchers determined how information quality impacts medication administration and contributes to medication errors. The researchers evaluated the information quality in the categories of validity, accuracy, completeness and timeliness. An interesting finding from the study was that often the handoffs resulted in errors detected earlier in the process thereby serving as a separate check by individuals executing the subsequent step in the process. The parameters in the study were focused on the quality of the information and also identified controls in the process that acted as preventative, detective or corrective activities (Chircu et al., 2013).

Business orientation is the way an organization looks at itself. If an organization sees itself as a collection of services it would be classified as having a "service orientation", if it saw itself as project based it would have a "project orientation", likewise, if it saw itself as a collection of business processes it would have a "business process orientation" (BPO). An organization can be viewed from an organizational chart perspective based on functional units and hierarchical reporting relationships or from the business processes being performed with the latter reflecting a BPO. The traditional business orientation has been described as having vertical functional units where people providing specialized services are grouped in

departments and business units with management roles in each of the departments and business units (Maddern, Smart, Maull, & Childe, 2014). This approach can result in suboptimal service for a customer (patient) since they would need to deal with several functional areas and information does not always flow efficiently between functional areas. The result is the patient may have to tell their story numerous times or key information is not transferred accurately or in a timely manner which could lead to serious errors. The transition of information and decisions between the silos adds waiting time or results in rework related to incomplete or inaccurate information flow. An alternate orientation has been described as a "horizontal" view in which the organization is process centric and views itself based on end-to-end processes that deliver value to their external and internal customers (Maddern et al., 2014). This business orientation is aligned with BPM because the main premise of both is that value creation and competitive advantage can be gained through focusing on business processes. In its purest form, a business process oriented organization would have an organizational chart that aligns with its business processes rather than the traditional organization structure based on functional units. In reality many organizations choose to maintain the traditional structure but incorporate a matrix management whereby process owners are identified for the core processes (Armistead & Machin, 1997).

Enterprise Architecture (EA) has been defined as "*a set of concepts and practices based on holistic systems thinking, principles of shared language, and the long-standing disciplines of engineering and architecture*" (Kappelman & Zachman, 2013, p. 87). EA originated when IT experts began developing models demonstrating how all the enterprise software applications were connected (Harmon, 2014). The discipline has evolved to now include not just the modeling of software applications but also the technology (hardware) aspects and the business processes using the applications and technology. EA is a

comprehensive description of key enterprise elements and the relationships between those elements (Kang, Lee, Choi, & Kim, 2010). There are numerous EA frameworks including: Zachman Framework for Enterprise Architecture, The Open Groups Architecture Framework (TOGAF), US Federal Enterprise Architecture Framework (FEAF), Business Architecture Guild of the Objects Management Group (BIZBOK), and Layered Enterprise Architecture Design (LEAD) to name a few (Harmon, 2014; von Rosing et al., 2014). The literature references a multitude of "architectures" or layers within the EA frameworks that when combined would represent a holistic EA. The FEAF framework includes four distinct architectures: Technology Architecture, Applications Architecture, Data Architecture and Business Architecture. The TOGAF framework includes three architectures: Technology Architecture, Information Systems Architecture, and Business Architecture. It has also been proposed that most frameworks include five layers: Business Architecture, Process Architecture, Integration Architecture, Software Architecture and Technology (or Infrastructure) Architecture (Winter & Fischer, 2006).

Layered Enterprise Architecture Design (LEAD) describes three layers of architecture. Layer 1 is the Business Layer which includes four sub layers: Purpose & Goal, Competency, Service and Process. Layer 2 is the Application Layer and it includes two sub layers: Application and Data. Layer 3 is the Technology Layer and it includes two sub layers: Platform and Infrastructure (Figure 3). This layered approach to enterprise architecture design enables development of models and meta-models which show the relationships between objects and meta-objects from one layer to objects and meta-objects within the same layer and also within the other layers.

Business Layer	Purpose & Goal (Value)
	Business Competency
	Business Service
	Business Process
Information Layer	Application
	Data
Technology Layer	Platform
	Infrastructure

Figure 3 Layered Enterprise Architecture Design

The LEAD standards provide a comprehensive enterprise architecture and related business ontology that enables the reuse of business objects across multiple layers of the architecture. The host organization had used LEAD's business layer as the principle enterprise architecture tool prior to commencement of this research. A formal analysis and comparison of the various enterprise architectures was not undertaken as selection of the 'best' enterprise architecture was not the focus of this research. Instead, the focus was the study of potential benefits and challenges of combining BPM, an ontology and the business layer of an enterprise architecture as a management approach to quality improvement within a healthcare organization.

The need to identify a suitable enterprise architecture for a hospital was the subject of an extensive study in which 17 different enterprise architecture frameworks were reviewed and 5 were shortlisted for evaluation. (Haghighathoseini, Bobarshad, Saghafi, Rezaei, & Bagherzadeh, 2018). . LEAD was not included in the list of frameworks reviewed. The Open Group Architecture Framework (TOGAF) was found to be the best suited to be used in hospitals. LEAD includes all the architectural elements within TOGAF with the added layer of Purpose and Goal in the business layer. This along with the convenience of being able to

reuse the business artefacts already created within the host organization using LEAD standards supported its selection for this research.

The BA layer of EA is the most relevant to the current research. BA and BPM are two different management disciplines which are closely related. However, reconciliation of the two disciplines is required to ensure the appropriate artefacts and their use is well understood (Dugan, 2014).

There are six advantages/common values associated with implementing an EA: 1) Readily available documentation of the enterprise, 2) Ability to unify and integrate the business processes across the enterprise, 3) Ability to unify and integrate data across the entries and to link with external partners, 4) Increased agility by lowering the complexity barrier, 5) Reduced solution delivery time and development costs by maximizing reuse of enterprise model and 6) Ability to create and maintain a common vision of the future shared by both the business and IT communities, driving continuous business/IT alignment (Brown, 2004).

Business artefacts such as strategy and business models can be very useful tools in developing understanding of an organization. The traditional organization chart does not provide a systems view of the organization. BPM requires that the principal focus of understanding the organization is through the perspective of its processes. It is important to understand both the processes and the context in which the processes are being executed (Harmon, 2014; Margherita, 2014).

BPM is used to better understand end-to-end processes and the relationships of the process steps to the other processes and objects within a system. Examples of objects would be location, roles, business rules, controls, cost, etc. This knowledge in turn can be used to improve processes. Cycle time, wait time, transport time, process cycle efficiency, error rate,

throughput and cost have been identified as seven basic measures that should be considered when undertaking process improvement (Kowalski, 2014). Errors in the medication management process occur both within the core processes and also within the management and supporting processes. A comprehensive measurement plan needs to incorporate all measurement types, not just the error rates. Also process improvement should be undertaken, not only in core processes, but also in support and management processes. The traditional focus in BPM is on the core processes only which has been viewed as a shortfall (Van der Aalst, Hofstede, & Weske, 2003).

There are four main criticisms of BPM identified in the literature. The first is BPM is merely a repackaging of old ideas by consultants and business gurus who are using it to promote their own business or "how to" books (Trkman, 2013). Second, there is an absence of a theoretical base in the literature (Melao & Pidd, 2000) which has since been addressed by several authors, although there does not appear to be consensus (Biazzo, 2002; Lacerda et al., 2010; Niehaves et al., 2014; Trkman, 2013). Third, BPM projects can take considerable time to complete and realize results (Siriam, 2012). Fourth, the majority of the articles are from practitioners reporting on successful case studies and very few articles reporting on failed BPM projects (Helfert, 2009).

Several authors have established the connection between BPM and 'systems thinking' (Maddern et al., 2014; Margherita, 2014; Siriam, 2012; Smart et al., 2009). Having a systems perspective requires us to not only measure and monitor the parts of the system but also requires that we measure the interactions and process between the various components of the system. This is especially true in healthcare as it has been shown that the greatest risk to patient safety is in the transitions between the component parts of the system (Chircu et al., 2013). The reductionist approach to control and performance measurement focuses on the

component parts. This approach has been critiqued and the author concludes that performance management must focus on the interactions between the components and not the components themselves (Gregory, 2007). This article is very persuasive and fits extremely well with the 'systems thinking' approach to organizational understanding and management.

2.4 Healthcare Organization as a System

In quality improvement literature a system has been defined as "*an interdependent group of items, people or processes with a common purpose"* (Langley, et al., 2009, p. 37). An organization can be perceived as an 'open system' or a 'closed system' with the main difference being that in a closed system the organization does not interact with the external environment whereas in an open system the organization interacts with and is affected by external environment factors (Khorasai & Almasifard, 2017). Important to note is an open system is more than a grouping of individual elements; it has an organization and wholeness. That is, it is more than the mere "sum of its parts". The concept of an "open system" is attributable to biologist, Ludwig von Bertalanffy (Peters, 2014). Thinking of the organization as an open system and realizing that it is more than the sum of its parts is foundational to BPM and the need to understand the end-to-end processes and the relationships both within the process and the relationships with the environment in which the processes are being executed.

A metaphor used to make the distinction between two types of systems underlying organizations is "*Organizations as machines, organizations as conversations*" (Suchman, 2011) Suchman claims that an organization can be viewed as a machine (dead - closed) system or as an adaptive (living - open) system and conversations are the basis for change in an adaptive system. The expectation of control within a machine type system is realistic as a machine can be controlled; however, such is not the case in an organization involving people

as they are not so easily controlled. Executing change in an adaptive (living) system requires focus on the human element to a much higher degree than in an organization characterized as a machine (Suchman, 2011).

Healthcare organizations have been described as complex adaptive systems (Begun, Zimmerman, & Dooley, 2003). The traditional view of a healthcare organization is the hierarchical organization chart, the simplicity of which belies the complexity of the nonlinear relationships and emergent nature of a complex adaptive system. Individual agents acting in a healthcare organization most often act independently based on their personal knowledge and the environment they are working in. Interconnectivity exists between the various functions or subsystems but these tend to be nonlinear and often small changes in one process or function can have major implications on other functions. Therefore, it is important that a systems approach be taken when initiating change in a healthcare organization.

W. E. Deming, an early pioneer of quality improvement, proposed that a system could be described as having three types of processes: Drivers or Influencers, Mainstay Processes and Support Processes (Langley, et al., 2009). This system of modeling has been used by the Jonkoping County Council to describe the health care system provided to the residents of Jonkoping County in Sweden. This organization has been identified as a high performing healthcare system and renowned for its ability to provide high quality health services at low cost (Baker, et al., 2008).

Seeing the whole system requires an understanding of structure, function and process and these must be understood at the same time (Gharajedaghi, 2011). EA and modeling can be employed to provide such a view. EA has often been viewed from an information technology perspective but this considers only one aspect of the system. A more holistic view of EA would include the representation of all elements of the enterprise and the

relationships between them (Mykityshyn & Rouse, 2007). Conceptual models provide a representation of an object or event and can be quite simple or very complex. An example of a simple conceptual model is a process flowchart that provides the steps in a simple linear process. An example of a complex conceptual model is a Business Process Model that depicts a process including the business process, the related information elements, software applications and technology used to support the business process. EA and the use of BPM are consistent with system thinking and could provide the tools and methodology to address the quality and cost challenges inherent in a healthcare organization.

2.5 Business Ontology

An ontology provides a set of terms and describes the relationship between the terms (O'Leary, 2010). Ontologies are the key building block of enterprise architecture which enables a holistic view of the enterprise where each functional area uses the same vocabulary to describe like objects (Kappelman & Zachman, 2013).

Four kinds of ontology have been described based on the level of generality. The four layers are top-level, domain, task and application (Guarino, 1998). Top–level ontology describes concepts related to objects, events, actions etc. at a very high level and is not dependent on a specific domain or particular problem. It is reasonable to assume a top-level ontology would be useful across a large user group since at the highest level of concepts everyone can agree on the meaning. A top-level ontology can also be referred to as a foundational ontology and is needed in any field or domain (von Rosing & Laurier, 2015). Domain ontology describes concepts using the vocabulary of a generic domain while task ontology uses the vocabulary of a specific task. Examples of concepts within a domain ontology are strategy, roles, cost, finance, or medicine. Examples of concepts within task ontology are analysis, design, investing, diagnosing or selling. Application ontology

describes concepts from both the domain and task ontologies and is a specialization of the ontology used from both (Guarino, 1998). A concept from a domain is a business process within a specific company and a concept from a task is data analysis within a specific department.

Business ontology has business as its area of discourse and it attempts to create a vocabulary that best represents relevant meaning that can then be shared through information exchange (Au-Yong-Oliveira & Ferreira, 2014). The exchange of information can be human to human, human to machine or machine to machine. Research in the area of business ontology has covered two different streams. The first included developing methodologies that enable practitioners to develop their own unique ontology specific to their domain. The second includes academic and standard setting bodies building of reference ontologies that could be tested and adopted by practitioners (von Rosing & Laurier, 2015).

BPMO is a domain ontology built on the top of the business ontology which is a foundational ontology (von Rosing et al., 2014). Both the business ontology and BPMO are generic ontologies applicable to various industries including healthcare. von Rosing and Zachman (2017) argue that the foundational business ontology and with it the BPMO is applicable to any type of organization, independent of complexity or industry. The business ontology can then be used as the basis for the development of integrated enterprise standards for any industry (von Rosing & von Scheel, 2016). Therefore, applying the business ontology to specific healthcare industry practices (medication management) is a research, analysis and study into the applicability of the business ontology and concepts in a specific industry setting. The current research required identifying the many different existing healthcare concepts from the value chain, the business model, the operating models, service and process model and applying them to the business ontology.

There are numerous ontologies described in the literature (Appendix 1). Ontologies have been developed by academics, standard setting bodies, architects or practitioners and in some cases through extensive collaboration between academics, practitioners and standards setting bodies. Ontologies evolve as they mature and more knowledge is gained due to expanded use or changes in business and technology. Two of the listed ontologies Health Language 7 (Health Level Seven International, 2015) and Basic Formal Ontology (Blobel et al., 2014) have been used in healthcare. The main use of both has been related to interoperability within and between clinical information systems with process automation as the goal. HL7 RIM (Reference Information Model) has evolved and is now referred to as RIM v3. *"HL7 v3 has been heavily criticized by the industry for being internally inconsistent even in its own documentation, too complex and expensive to implement and has been accused of contributing towards many failed and stalled systems implementations"* (Bender & Sartipi, 2013, p. 326). BFO is a foundational or upper level ontology designed for use in bio-informatics to guide the development of domain ontologies.

The business ontology and BPMO developed by Global University Alliance was selected for use in this research as it covers both the clinical and business aspects of medication management processes. The ontology is designed in layers enabling the incremental adoption across the organization. This ontology has been adopted by several software vendors including SAP (Rosenberg, Chase, Omar, Taylor, & von Rosing, 2011), iGrafx (iGrafx, 2013), and Objects Management Group (OMG) a well-known software standards organization (Object Management Group, 2014). It has also been academically well described with published case studies demonstrating its utility (von Rosing & Laurier, 2015; von Rosing & von Scheel, 2016; von Rosing, Urquhart, & Zachman, 2015). A detailed description of the business ontology and BPMO is provided in Appendix 1.

2.6 Reference Models

A reference model is either a narrative or visual conceptual representation of the recommended (best) practices of a specific domain. In this research, the medication management process reference model is a narrative representation of the processes that should be included in a process architecture for medication management. A business process reference model can be used to inform and guide the development of a business process where no such business model previously existed or it can be used to compare current business process to the generic reference model which has incorporated leading or best practices within the domain (Pajik, Indihar-Stemberger, & Kovacic, 2012). Since developing business process models is time consuming and can be expensive, reference models can be used to shorten the time to design or standardize process models across an organization.

The challenge with producing generic business process models is they may be context specific; therefore, not necessarily transferrable to other organizations. It is possible that best practice in one organizational or industry may not translate to best practice in another organization if there is a major difference in the strategy of the two organizations (Ponsignon et al., 2012). Despite these concerns there are many examples of reference models for business process in use and referenced in the literature. These include SCOR – Supply Chain Operations Reference Model, SAP R/3 reference model and the Process Classification Frameworks developed and published by the American Productivity and Quality Council (APQC) (Pajik et al., 2012; American Productivity and Quality Centre (APQC), 2014).

There were two sources of information available for use in validating the business process reference model for medication management: the APQC Process Classification

Framework, and the Supply Chain Operations Reference (SCOR) (Supply Chain Council Inc., 2012). Further information on how these were used is reported in Section 4.4.

2.7 Literature Review Summary

The occurrence of medication errors and the resulting adverse drug events are a problem in hospitals and long term care facilities. The literature shows that the medication administration phase is one of the most error prone and that there is a low likelihood that these errors will be intercepted. Technology has been proposed as a potential solution for reducing medication errors; however, simplification and standardization of processes is required in order for the technology to be effective in reducing medication errors. Clinicians would need to accept the technology and associated changes to their workflow.

The medication processes are subject to numerous standards, guidelines and legislative requirements that must be met within the processes. While these controls are intended to provide for a high quality medication management process they also contribute to the complexity of the processes.

Researchers and practitioners have contributed to the literature on BPM. The definition of BPM ranges from very narrow to very comprehensive depending on whether one is looking at a single process or encompassing an entire organizational view including suppliers and customers. There has been differing views on the theoretical basis of BPM. Several authors agree on the evolution of BPM and claim it is an improvement over the predecessor approaches because it incorporates the benefits of its predecessor traditions. The applicability of BPM in a complex system such as healthcare has been questioned because of the high degree of the 'human element' that must be considered when designing processes where individuals may need (or choose) to deviate from 'standard' processes. The three

elements of modeling, measurement and management of processes are foundational to BPM. BA provides the structure in which business processes can be explored.

The need to look at processes from a systems perspective has been established as desirable if maximum value from the organization is to be realized. This 'systems thinking' approach is especially important in organizations such as healthcare, which are traditionally hierarchical organizations that rely on individual clinical expertise to assess, diagnose, treat and monitor patients.

Business ontology provides the ability to create a shared vocabulary across domains. This shared vocabulary will create a shared understanding that could contribute to reducing complexity which in turn would reduce errors related to communication challenges. A shared understanding of the process and its underlying objects could facilitate process automation and reduction in variation in outcomes.

Developing process models is a time consuming and costly activity which could be expedited by having access to a process reference model. Process reference models have been developed in many business sectors but no process reference model specific to medication management in hospitals and long term care facilities was discovered in the literature review.

The literature review provided examples of how BPM had been employed on specific healthcare processes but there were no articles found that showed the use of a combination of BPM, EA and business ontology. In order to determine whether a research gap existed in this area, a comprehensive literature review was conducted using BPM, EA and ontology as the keywords. Several premier databases were searched for recent peer reviewed articles. It was observed that while extensive research has been done in the areas of BPM and EA, there has not been any effort towards using ontology to combine concepts from these two

disciplines. Similarly, this concept of using ontology to integrate BPM and EA in the context of healthcare organizations was found to be non-existent. One article reviewed, however, made the case for using EA and BPM to improve quality of health care services (Wouters, 2015).

3 Methodology

This chapter outlines the methodology and the research design used in the development of this dissertation. There are three sections in this chapter. The first section briefly presents the rationale for using the mixed methods research methodology to address the research questions. The second section outlines the research design. The third section provides detail on the reliability, validity, generalizability, and limitations of this research.

3.1 Approach

There are two approaches to research: the deductive approach and the inductive approach. The deductive approach begins with the researcher asserting a theory, he or she would then develop a hypothesis related to the theory, collect and analyze data to either confirm or reject the theory and then if appropriate propose a revised theory (Bryman, Bell, Mills, & Yue, 2011). The inductive approach does not lead with a theory; rather, the researcher starts with a question(s), collects and interprets the data to develop concepts and theories based on the interpretation of the data and will often add more specificity to the research questions as he or she gains additional knowledge from the interpretation of the data (Bryman et al., 2011).

This research had two purposes; firstly, to determine if an ontology used in other industries could be successfully applied to the healthcare industry and secondly, identify the benefits and challenges of introducing BPM, Business Ontology and BA as a comprehensive approach to address medication management safety and quality concerns within a multi-facility healthcare organization. The exploration of introducing the ontology could be considered to be deductive approach while the identification of benefits and challenges of introducing the combined approach to quality improvement could be considered to be inductive approach. The development of the business artefacts and the use of those to

develop a generic reference model for medication management was a secondary focus that is more closely associated with design science. The focus therefore, was theory testing in respect to introduction of the ontology and problem solving, design and theory generation in respect to identifying the benefits and challenges.

The methodology selected was mixed methods as opposed to purely quantitative or purely qualitative methods. The research design employed predominantly qualitative methods with embedded quantitative methods. Mixed methods has been described as *"the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study"* (Johnson & Onwuegbuzie, 2004, p. 17). Qualitative design in the form of researcher facilitated workshops was used to develop business artefacts, select performance measures, and identify improvement opportunities. Semi-structured interviews were used to identify the challenges and benefits as perceived by the members of the medication management working group. Also, leaders of the host organization were interviewed using a different set of questions to gather data on the benefits and challenges of using BPM, BPMO and BA from a leader's perspective. Quantitative design was used to analyze the organizational performance measures and prioritize the improvement opportunities. Figure 4 shows the methods used and their classification as either qualitative or quantitative. Each of the methods is discussed further in the Strategy and Research Design section below.

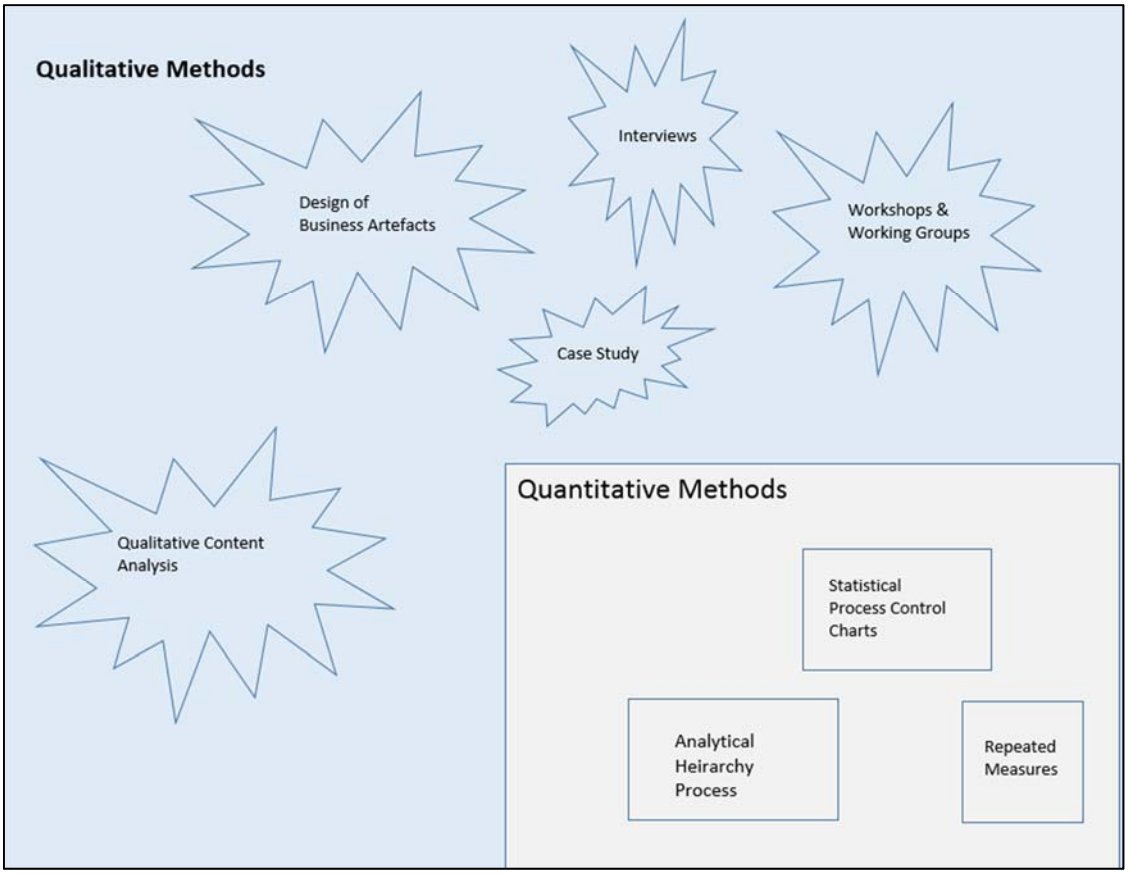


Figure 4. Combining Qualitative and Quantitative Methods & Techniques

3.2 Strategy & Research Design

Mixed methods design is often used in health services research (O'Cathain, Murphy, & Nicholl, 2007). There are six types of mixed method strategies and it is important to consider four aspects of the research before selecting which type of mixed method design to use (Creswell, 2014). The six strategies are: sequential explanatory, sequential exploratory, sequential transformative, concurrent triangulation, concurrent embedded and concurrent transformative. The first three sequential strategies are used when the research is conducted in phases with one of the designs (i.e. quantitative or qualitative) used in one phase followed by the alternate in subsequent phases. The concurrent strategies are used when the data from both qualitative and quantitative approach is collected concurrently. The four aspects are: timing, weighting, mixing and theorizing. In this research, the respective research methods

are used concurrently; while the qualitative method weighed more heavily, the quantitative method was embedded within the more dominant qualitative approach and the theorizing was implicit. Qualitative methods have been described as suitable to be used when researchers want to ask more questions than can be answered by quantitative methods, particularly in complex environments (O'Cathain et al., 2007). The prioritization of improvement initatives, and measurement and analysis of change were better suited to a quantitaive approach. Therefore, both approaches were needed which resulted in the selection of a mixed methods designbased on a concurrent embedded strategy.

Figure 5 provides an overview of the ten step research design that was developed and used. In addition to the numbered steps, the figure outlines the major tasks included in each step. The lessons learned in following this design are summarized in Table 5.

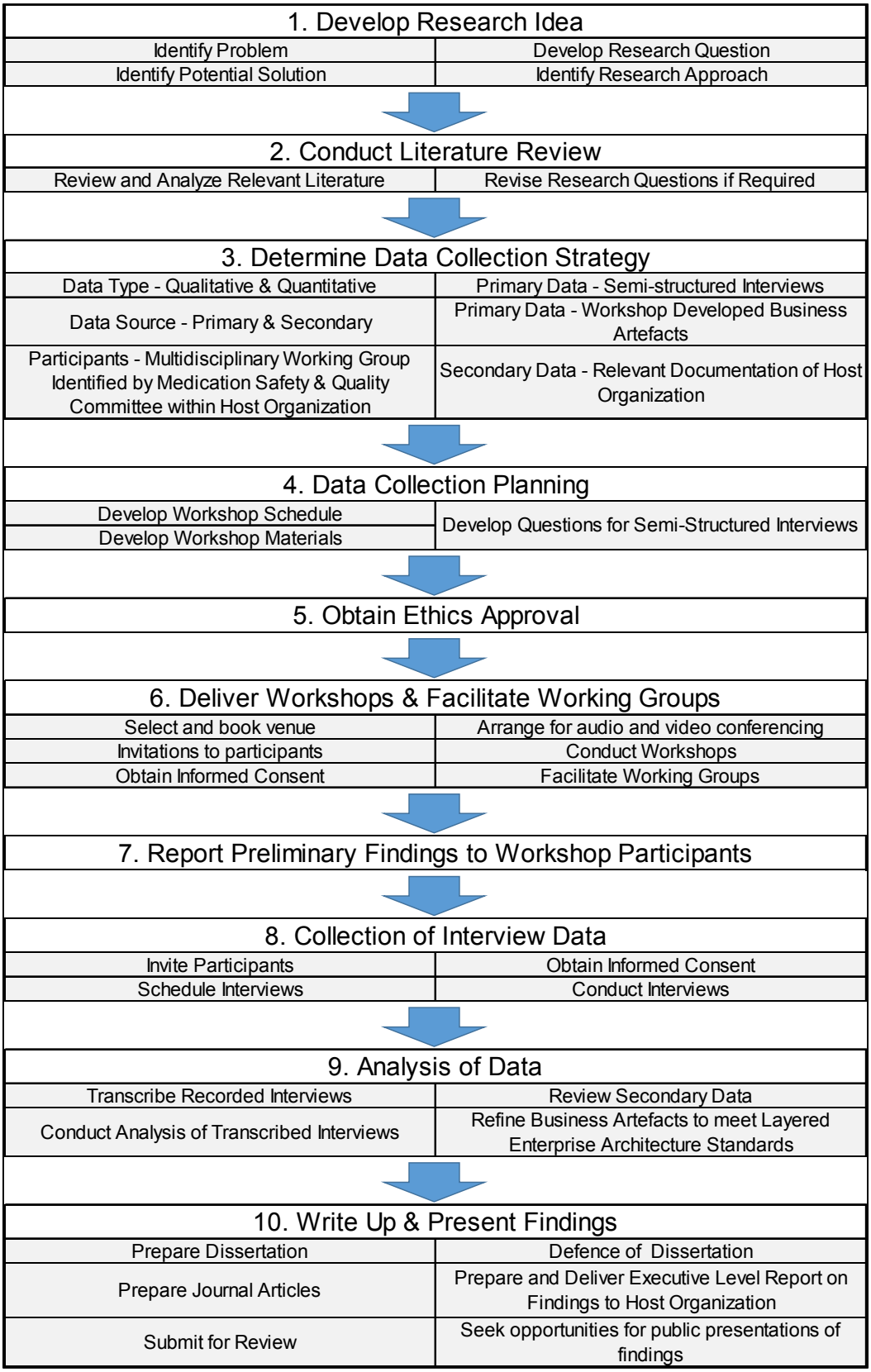


Figure 5. Research Design

Table 5 Considerations for Replication of Study

Stage	Key Points	Opportunities for Improvement and comments
Develop Research Idea	Medication Management was used an example of a quality improvement focus that might benefit from the use of the comprehensive management approach. Other service areas could be considered	
	*Need to identify and confirm a host organization willing to engage in the research *Need to identify and engage a project sponsor within the host organization	*Recommendation to find a host organization which the researcher has no immediate or recent employment relationship. *Executive support is critical as the approach requires participation from the host organization *An organization considered to be a "Learning organization" as in most cases the approach and some of the concepts will be new to the participants and leaders
Conduct Literature Review	Follow a formal literature review approach	*Expand the literature to include relevant sources and white papers that specifically address the problem to understand what is currently being undertaken by practitioners that may not be included yet in academic publications.
Determine Data Collection Strategy	Work with Project Sponsor to identify workshop participants	*Ensure the workshop participant group is representative of the end to end process being reviewed * Include both operational and management staff if possible.
	Primary Data Collection for use in development of Business Artefacts	*Engage a research assistant to attend workshops or arrange for audio recording and transcription to ensure complete capture of all ideas and

Stage	Key Points	Opportunities for Improvement and comments
		discussions related to the business objects to be included within the Business Artefacts.
	Secondary Data – Relevant documentation of host organization	Recommend review of all organization strategic level documents as well as any specific strategy and planning document in the focus area.
Data Collection Planning	Develop Workshop Schedule	*The ½ day workshop seemed to work well so would recommend that approach but plan on 4 sessions rather than 3 sessions and have them spread out over a four week period so participants have time to review and reflect on the work but not so far apart that they lose momentum with the development of the business artefacts. *The translation of the ideas into the relevant business objects and documentation will take some time so be sure to leave time available for transcribing and editing between the research dates so that participants can have time to conduct preliminary review of the draft business artefacts prior to each work shop.
	Develop Workshop Materials	*The introduction to the research and the orientation to BPM, BA and the BPMO sets the foundation of the research and therefore should be developed such that it is understandable to those being exposed to it for the first time. * Wherever feasible, include examples relevant to the focus area and also if possible from review of secondary data of host organization where it exists.
	Develop Questions for Semi-Structured Interviews	Validate the interview questions.

Stage	Key Points	Opportunities for Improvement and comments
Obtain Ethics Approval	Allow for time as this process can take time depending on review and approval processes within host organization.	
Deliver Workshops & Facilitate Working Groups	Arrange for audio and video conferencing if participants are geographically dispersed	Include audio recording since this will ensure completeness of data collection of business objects to be included in business artefacts.
	Conduct workshops	A formal consensus developing method such as modified Delphi approach could be added as this would strengthen the "consensus" that the resulting business objects included within the business artefacts are agreed to by all participants.
	Facilitate working groups	The working group schedule in the current study was less than ideal due to availability of participants. This extended the duration of the research significantly. It would be advisable to have weekly meetings of the working groups rather than monthly.
Report Preliminary Findings to Workshop Participants	The working groups were formed from a sub group of the Workshop Participants and it was important to share the results with the workshop participants so they had a full picture of the results including the prioritization and performance measures to be added to the business artefacts.	
Collection of Interview Data	Voluntary participation was lower than expected despite several reminders after initial invitations were sent.	Try additional recruitment strategies

Stage	Key Points	Opportunities for Improvement and comments
Analysis of Data	Analysis of interview data using thematic and content analysis Design of business artefacts based on LEAD standards	
Write Up & Present Findings	Disseminate results to research community periodically to obtain feedback.	

3.2.1 Research idea – motivation. The research idea evolved from an interest in resource allocation, quality improvement, and strategy execution in healthcare. The challenge of meeting healthcare demands within the resources available is an issue for both healthcare providers and healthcare administrators. There is a constant need to realize as much benefit as possible from the resources available. This is true from the perspective of provision of healthcare services and also from the perspective of how we employ resources engaged in improving the effectiveness and efficiency of healthcare services. At the system or macro level, resource allocation decisions determine what services will be provided while at the micro level individual clinicians decide on a case by case basis how they will allocate their clinical time.

There is little debate on the need for improvement in the quality of healthcare services. An essential area of interest is medication management due to the frequency of medication use in the treatment of patients and the high risk posed from adverse medication events. In addition to patient safety, the efficiency and effectiveness of medication management processes are extremely important. These processes consume resources in the

form of human resources and in pharmaceutical supply costs. Errors in medication management result in undesirable outcomes which range in significance from extreme such as the death of a patient due to an adverse medication error to less obvious issues such as overstocking inventory that results in a waste of money due to expired drugs.

The literature reports on approaches to reduce medication management errors some of which are included in Chapter 2. The host organization for this research had previously employed some of those approaches with limited success. The use of more advanced technology supported solutions that enable automation of processes are extremely expensive. Although there is a growing movement within the host organization to proceed with that approach, it is recognized that processes should be improved and standardized in advance of introducing new technology.

Healthcare organizations have been described as complex adaptive systems. One of the key attributes of such a system is that a small change in one area can result in unexpected results in a different area within the system. Therefore, it was critically important to gain a comprehensive understanding of the system in which medication management operates before attempting to introduce changes. An additional point to consider was that healthcare providers have a high degree of autonomy in their work and therefore when changes were being contemplated it was important to engage individuals involved in the processes in redesign planning. These two points weighed heavily in the identification of potential solutions and choice of the research approach. Using workshops as a means of developing the business artefacts and identifying critical processes for improvement provided participants the opportunity to engage early in the solution identification. Exposure to the organizational BA provided participants with the opportunity to increase their understanding of how medication management processes fit within the larger healthcare system.

3.2.2 Literature review. The literature review provided in Chapter 2 evolved from the initial research idea generation step through to the final step of writing up and presenting the findings. The research step of conducting a literature review included searching, reading, and critically appraising the literature on the topic(s) of interest. This process facilitated achievement of a greater understanding of both the problem and the potential solutions. The literature review was also instrumental in shaping the research questions and developing the research design.

3.2.3 Data collection strategy. The data collection strategy included identifying what type of data would be collected, whom the data would be collected from, and how the data would be collected. The type of data included both qualitative and quantitative data. The source of primary data was the workshops and semi-structured interviews. The source of secondary data was the host organization records and information management systems. The host organization had established a Medication Safety & Quality Committee (MSQC) and in recognition of this research the researcher participated as a non-voting member of the group. Identification of the appropriate individuals to be included in the multi-disciplinary team was based on the recommendation of that committee. Those individuals recommended included: Nurse Managers, Medication Safety Nurse, Pharmacists, Information Management Director, Chief Medication Information Officer, physicians and performance improvement practitioners, all of whom participated or had knowledge of some aspect of the medication management processes. Agendas and minutes of the MSQC meetings were reviewed to identify any additional initiatives or interventions undertaken in medication management

during the research period. The results of that review are included in the Chapter 4 and further discussed in Chapter 5.

3.2.4 Plan for primary data collection. The collection plan for the primary data included two components. The first was the information and business artefacts derived from the workshops and working groups' activities. The second was the data collected through semi-structured interviews with workshop participants and host organization's leaders.

Planning for the workshops required preparation of material for presentation to the group, both on the research project itself, as well as educational material on BPM, BPMO, and BA. There were initially two full day workshops planned however, due to scheduling challenges with operational responsibilities of the participants the plan was changed to two half day workshops to be held one week apart. The scheduling included capacity for video and audio conferencing to accommodate participation from outside the local area. The host organization provides services across a large geographic area and it is common practice for staff of the organization to participate in organization wide activities using these types of communication technology.

Prior to the formal research, the organization had undertaken to develop strategy maps and business models both at the organization level and at the organizational area level. The draft business model and a draft strategy map for the organization area of Pharmacy served as the starting point for the development of the Medication Management business model and strategy map presented in Chapter 4. The plan was to have these two documents reviewed, expanded upon as appropriate and validated by the workshop participants. In addition to these two business artefacts, there were also numerous process models in a process repository relevant to this research. Those business artefacts were foundational in the preparation of the initial workshop material. The draft business model and strategy map

had been based on input from individuals in management positions within pharmacy services so those business artefacts needed to be expanded to include input from other business areas. There had been a limited number of participants involved in development of the initial draft of the business model and strategy map. In an effort to promote buy-in and be sure the artefacts were complete and appropriately represented the service area additional consultation was required. During the planning for the initial workshop, a draft value chain for medication management was developed based on the review of the business artefacts noted above and discussions with the Regional Director of Pharmacy.

The agenda for the first workshop included four items:

1) Introduction to the research

2) Introduction to BPM, BPMO and BA,

3) Review of draft strategy map and business model

4) Discussion on development of an end-to-end process model of medication management.

Chapter 4 provides further detail on the addition of a third half day workshop and also the formation of two working groups one focused on measurement and the other focused on prioritization activities. This level of effort had not been anticipated during the planning of the research; however, there was a higher level of engagement and discussion during the workshops than had been planned for initially.

The plan included two separate groups to be invited to participate in semi-structured interviews. The first group included all participants from the workshops except two individuals who were support staff within the BPM business unit. Twenty workshop participants were invited and eleven agreed to be interviewed for a response rate of 55%. The second group invited to participate in an interview were the senior leaders within the

host organization. The senior leaders were identified by reviewing the organizational chart and invitations were delivered to all members of the Executive Team as well as all leaders who directly reported to an Executive Team member. Seventy leaders were invited and 23 agreed to be interviewed for a response rate of 33%. Two separate interview instruments were developed, one for the workshop participants and the other for the leaders. Copies of both interview instruments are included in the Appendices as Appendix 2 and Appendix 3. There were two individuals who fit both criteria for inclusion and these two were interviewed twice using the different interview instruments.

3.2.5 Ethics approval. This research included human subjects and as such ethics approval for the research was required. Northern Health signed on as a partner in this research and joint ethics approval was granted by UNBC Research Ethics Board and the NH Research Ethics Board. Members of the Multi-disciplinary Working Group (MDWG) were informed of the research. Informed consent was obtained from each member of the MDWG who participated in the workshops. A copy of the information letter and consent form is provided as Appendix 4. Informed consent was also received from individuals who agreed to participate in the semi-structured interviews. Appendix 5 is a copy of the amended information letter and consent form for the interviews. The initial ethics approval stated that the researcher would complete all the transcription of the recorded interviews. This decision was revisited and an amendment of the ethics application was filed and approved. The transcription of the recorded interviews was achieved by a combination of a hired transcriptionist and the researcher.

3.2.6 Delivery of workshops and facilitation of working groups. Three half day, researcher-led, workshops were delivered and these were followed up with monthly working group meetings. The workshops were held between December 2016 and January 24, 2017

and the two working groups met monthly between February and September 2017. Each of the two working groups focused on finalizing the work that had been initiated in the workshops. The Measurement Working Group (MWG) focused on the performance management plan and the Prioritization Working Group (PWG) focused on reviewing the identified process improvement opportunities and finalizing the prioritization. The PWG completed the prioritization exercise and all proposed improvement initiatives suitable for ranking were prioritized. Those initiatives not prioritized had either been completed previously or were mandatory initiatives. The MWG developed a listing of performance measures for inclusion in a scorecard for medication management safety and quality but were challenged to deliver a final complete product because some of the measures were not yet available

Workshop meeting materials were circulated in advance and both the workshops and the working group activities were facilitator led. Participants were invited to ask questions or request clarification on the documents prior to or during the workshops and working group meetings. The first two workshops were held in December 2016 and the third was held in January 2017. The attendance varied from a high of twenty-two in the first workshop to a low of thirteen in the third workshop. Appendix 6 provides a log of the workshop attendees including position title and professional background. Members of the two working groups were volunteers from the workshop participants with the exception of a financial business analyst who had not participated in the workshops but did participate in the measurement working group. All workshop participants were invited to participate on the working groups if they were available and interested. The attendance at working group meetings ran between five and seven individuals with a small group that formed the core of both groups. This core group included: the Regional Director of Pharmacy, the Antimicrobial Stewardship

Pharmacist and the Lead, Regional Quality Processes who consistently participated in both working groups. Participants were encouraged to challenge both their own assumptions and ideas as well as those of others. Efforts were made to create an atmosphere of trust and mutual cooperation during the workshops and working group activities.

The workshop participants finalized the development of the business artefacts that met the LEADing practice BPMO standards by the end of the second workshop. The artefacts included the relevant business competency model, organization strategy map, value chain and some but not all of the process models related to medication management safety and quality. In addition to the business artefacts listed above, two additional deliverables were achieved through the working groups. These included the draft performance management plan and a prioritized list of process improvement opportunities.

A repeated measures design to collect the performance measures was planned. This included both key process indicators and key performance indicators. The list of selected performance measures is provided as Appendix 7.

Analytical Hierarchy Process (AHP) is a methodology intended to compare and contrast alternative options in order to rank the relative contribution each could make towards achievement of an overall goal (Saaty T. L., 1980). The AHP scoring tool enables the conversion of a pairwise comparison of decision criteria from a verbal scale to a numerical value which can then be used to establish a weighting for each criteria being compared (Table 8). The alternative options can then be rated against the weighted criteria and ranked based on their relative value.

There are three steps in the AHP. The first step is to identify the numerical weighting of the decision criteria using a pairwise comparison matrix (Table 9). The second step is to calculate the relative score of each option (Appendix 15). The third step is to rank the

options based on numeric score from highest to lowest (Appendix 16). Further discussion of how the methodology was used and results of the analysis are provided in Chapters 4 and 5.

AHP is based on four axioms: 1) comparability, 2) hierarchy, 3) homogeneity and 4) completeness. Comparability refers to the need to measure relative value of two alternatives when making a pairwise comparison. Hierarchy refers to the need to arrange options in declining order to support decision making. Homogeneity refers to the need to compare things of a similar nature. Completeness refers to the expectation that the ranked list includes all relevant options under consideration (Saaty & Kulakowski, 2016).

3.2.6.1 Procedures and tools. Prior to this research in the host organization, development of draft organizational business artefacts had been achieved through consultation with business area subject matter experts in the respective business areas within the health authority. There were twenty-three organizational areas identified and each area had a draft business competency model and a draft strategy map. Modeling standards and objects included in the business artefacts and process models were based on the standards of LEADing Practice which had been researched and developed by members of the Global University Alliance and LEADing Practice certified practitioners.

BPM methodology was used in the development of the end-to-end medication management process model, process measures and outcome measures. Analysis of the process facilitated the identification of improvement opportunities. It is acknowledged that the improvement opportunities identified exceeded the available resources; therefore, as suggested by (Siriam, 2012), AHP was used to identify those that were likely to have the most benefit to the overall process. The process models were developed using Business Process Management Notation (BPMN) as the modeling language. Business artefacts

including all process models were documented using iGRAFX software system and/or Microsoft Excel.

Layered Enterprise Architecture Design (LEAD) includes three layers of architecture as described in section 2.3. Figure 3 shows the three layers and 8 sub layers of LEAD. This layered approach to enterprise architecture design enables development of models and meta-models illustrating the relationships between objects and meta-objects within, and across other layers. The ability to identify and model the relationships requires a common vocabulary be used throughout the layers and sub layers. Researchers associated with the Global University Alliance and practitioners engaged with LEADing Practice have developed a Business Ontology that covers all aspects of business including the three layers as defined in the LEAD (von Rosing & Laurier, 2015). The development of business artefacts for medication management applied the BPMO to the objects within the business layer only. The objects within the application and technology layer were considered to be out of scope and therefore not included in this research.

3.2.7 Interim reporting. Progress reports were provided to the MSQC to keep them apprised of the progress on development of business artefacts and identification of improvement initiatives. The MSQC members were provided revised copies of the business artefacts as they were developed and verbal updates were provided on the activities undertaken by participants in the workshops and working groups. Workshop participants were invited to a wrap up meeting in October 2017. This provided an opportunity for workshop participants who had not participated in the smaller working groups to review and comment on the final performance measurement plan and the ranked list of improvement initiatives. The finalized business artefacts including process maturity evaluation results, prioritized listing of the planned improvements and listing of the performance measures were

provided in advance of the meeting. There was a considerable level of discussion on the prioritized improvement initiative list which will be discussed further in Chapters 4 and 5.

3.2.8 Collection of data. Data collection included both primary data and secondary data. The primary data included recorded interviews with host organization staff in October and November 2017. The recorded interviews were subsequently transcribed and analyzed using a thematic content analysis approach. The workshops and working group provided primary data consisting of medication management business artefacts, listing of performance measures and ranked list of process improvement initiatives.

Secondary data consisted of host organization business artefacts, performance measure values, MSQC meeting minutes, and operational planning documents. This secondary data and its impact on the results will be discussed further in Chapters 4 and 5.

3.2.9 Analysis of data. In addition to the AHP, two other analytic activities were undertaken. These included analysis of: 1) the performance measures selected for inclusion in the performance management plan and 2) the transcriptions of the two sets of recorded interviews.

The performance measurement data was analyzed using statistical process control charts or Shewart charts developed in Microsoft Excel. This approach is well suited to determine whether a change in a process has resulted in an improvement (Benneyan, Lloyd, & Plesk, 2003). Process control charts were used to analyze the performance measures to determine if there was a statistical change in the performance measures subsequent to the implemented process improvements identified during the research. A statistical process control chart enables determination of the type of cause resulting from the change in the value of a measurement. The cause is categorized as either due to common cause (random) variation or special cause variation. It can also be used to determine whether there is a

"trend" in the data. The repeated measures are plotted on a run chart and the upper and lower control limits are calculated based on the standard deviation from the mean. Three deviations above the mean is used to show the upper control limit and three standard deviations below the mean is used to show the lower limit. If the lower limit calculation results in a negative number then zero is used as the lower limit. Two examples of an indication of a "special cause" would be a single point outside the control limits or a succession of eight data points in a row either all above or all below the average. Figure 6 provides an example of a process control chart showing the use of the master drug library (MDL) for medication infusions on one inpatient ward where a quality improvement initiative had been implemented. The detail related to that initiative is provided in section 4.2.1. The performance measurement plan includes those measures reported to senior executive on a fiscal period basis. No measures other than the one shown in Figure 6 have been reported in this document since the quality improvement initiatives had not been completed during the research period and many of the measures were not yet available. The administrative burden of collecting the measures needs to be addressed and the intent is to develop appropriate software solutions to automate the process as much as possible.

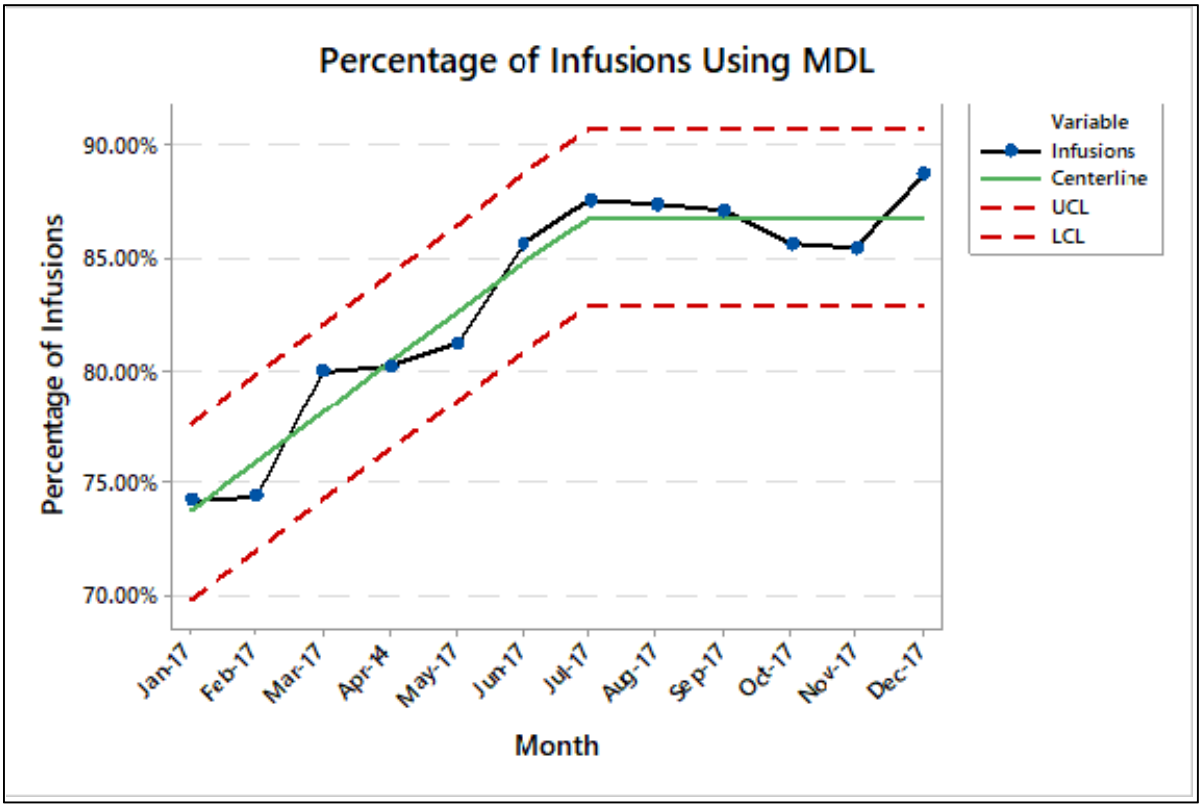


Figure 6 Statistical Control Chant showing Percentage of Infusions Using MDL Prepared using Minitab 18 Statistical Software (2018)

The interview data was analyzed using NVIVO software. The analysis was undertaken as three separate activities. The first analysis included only the transcripts of the interviews with the workshop participants. The second analysis included only the transcripts of the interviews with the leaders. The third analysis used a summative approach to content analysis which examined and compared the use of language by interview respondents. There were two comparisons made; the first was the language used between clinical leaders and non-clinical leaders, and the second was between responses from workshop participants and those of the leaders.

Thematic content analysis is, "*a useful approach for answering questions about the salient issues for particular groups of respondents or identifying typical responses*" (Green & Thorgood, 2004, p. 177) . Thematic content analysis was employed to analyze the transcripts

from both sets of interviews. The coding was undertaken by one coder and the analysis followed a cyclical process where each transcript was read individually to understand the text, it was re-read to identify preliminary themes which were coded in NVIVO, the preliminary themes were grouped into clusters and themes were tabulated in a summary table, thereby going from specifics to generalizations.

Summative content analysis was used to examine the language used. The preliminary identification was achieved through the automatic queries available in NVIVO software. The results of the automatic queries were analyzed using Microsoft Excel.

Other qualitative data analysis approaches considered were Interpretative Phenomenological Analysis (IPA) and grounded theory. It was decided to use the content analysis approach (both thematic content analysis and summative content analysis) as it was more suited to the questions. IPA is more suited when you want to analyze in depth responses at an individual level and is most often used in psychology studies. Grounded theory was also a viable methodology; however, this approach requires selection of the approach at the outset of the research. This methodology had not been selected at the outset; therefore, the content analysis was a more appropriate choice.

3.3 Reliability, Validity, Generalizability and Limitations

Reliability, validity and generalizability as it refers to quantitative research can be challenging to achieve in qualitative research. It has been proposed that the definitions assigned to these terms in the context of quantitative research should be adjusted for qualitative research (Bryman et al., 2011). It has also been proposed that the two primary criteria for assessing the quality of a qualitative study should be trustworthiness and authenticity (Guba, 1985).

3.4 Trustworthiness

Trustworthiness addresses four criteria that parallel the quantitative research criteria of internal validity, external validity, reliability and objectivity. The four criteria are credibility, transferability, dependability and confirmability respectively.

Credibility (or internal validity) can be inferred with respect to the business artefacts since the researcher worked with a group of clinicians engaged in Medication Management to develop and validate the artefacts. The credibility of the results of the analysis of the interview transcripts is less straight forward since there is always a risk the beliefs of the researcher influenced the results of the analysis despite best efforts to be objective in the interpretation.

Transferability (or external validity) of the findings to another healthcare organization or indeed to another organization is questionable since the culture of the organization along with the experiences, views and beliefs of the participants played a major role in the outcome. That being said, the medication management process itself is highly regulated so it is reasonable to believe the process models and business artefacts could be transferable, at least in part, to other healthcare organizations which are subject to similar regulations and legislation. The process of engaging the participants, conducting the workshops, developing the business artefacts and using AHP to rank the improvement initiatives is transferable although the results would be different based on the social context of the host organization.

Dependability (or reliability) could be shown through an audit of the research documents, interview recordings and secondary data of the host organization. The research was overseen by the PhD Supervisory Committee which contributed to the dependability of the research. An audit is neither reasonable nor feasible and reliance of the dependability of

the research is attributed to the researcher and the academics who supported it. Ethics review of the research plan also contributed to the dependability of the research.

Confirmability (or objectivity) with respect to the degree the researcher was objective throughout the research is, like dependability, difficult to ascertain. The researcher, was also an employee within the host organization and this in and of itself could be viewed as compromising objectivity. Steps were taken to mitigate any situations where a participant may have felt that this dual role influenced them or their contributions. The interviews were restricted to peer level or senior leaders within the organization. The area of research 'medication management' is in a different portfolio within the organization then the portfolio the researcher worked in. The Regional Director of Pharmacy played a meaningful role in all discussions and review of the final results which would strengthen the objectivity. No interviews were conducted with members of the researcher's portfolio so as not to create an undue influence. The researcher, as an employee of the organization, did enjoy a level of accessibility to the host organization records and staff which is often not available to external researchers.

3.5 Authenticity

Authenticity in qualitative research has not been as influential as the trustworthiness criteria; however, it has been seen to be relevant to action research where practical outcomes are sought (Bryman et al., 2011). The criteria included in authenticity includes: fairness, ontological authenticity, educative authenticity, catalytic authenticity and tactical authenticity.

Fairness requires all levels of organization be involved and in this research there were participants from senior and middle management levels within the organization. Front line care providers were not included in the workshops nor were they interviewed. There was not

a conscious decision to exclude front line practitioners but rather it was a consequence of operational constraints and the fact participants joined the research on a voluntary basis. It could be assumed that this lack of front line participation limits the fairness of the process due to the absence of the opinions and beliefs of this level within the organization. This would in turn be partially offset since the front line managers themselves were mainly clinicians some with very recent front line experience.

The analysis of the process from end-to-end brought insight into the social context in which staff worked and how their actions might affect others participating in the process either upstream or downstream. This exploration across organizational boundaries contributed to the ontological authenticity which requires that the research helps people engaged in the medication management process gain a better understanding of how they fit into the social context of their environment.

The development of the business artefacts and selection of improvement efforts generated discussion and varying perspectives were heard by the participants some of which were not known by all workshop participants prior to this research. This contributed to educative authenticity which requires the research provide participants with an opportunity to gain insight into perspectives of other members within the social setting.

This research provided an opportunity for individuals to explore the value being delivered through medication management and also how that value might be increased through improvements in the processes. Follow up research would show whether or not individuals took action subsequent to the research being completed but based on comments made during the interviews the participants indicate that they have already begun to implement improvements or were planning to do so. This contributed to catalytic

authenticity which requires that individuals change their approach or engage in some sort of action to change their circumstances.

The development of the business artefacts and the increased understanding of the entire end-to-end medication management process that each of the participants gained could definitely increase their ability to engage in informed discussion on where changes could or should be undertaken to increase safety and quality of medication management processes. Identification and review of the Strategic Business Objectives and the Critical Success Factors provided clarity and a shared understanding on what was intended to be achieved and why. This contributed to tactical authenticity that refers to whether participant's level of empowerment to take action had increased as a result of the research.

3.6 Limitations

This research has the limitations associated with action research some of which are referred to in section 3.3.2. The limitations can be categorized into three themes: 1) timing, 2) objectivity and 3) transferability.

There were two issues related to timing. The research was conducted over an eleven month period which means there were changes happening within the organization during the time of the research which may or may not have affected the outcomes. The time frame of the research was not of a duration to fully realize the implementation of the improvement initiatives and therefore the performance data does not demonstrate the full impact of the anticipated changes in process outcomes.

Objectivity of the researcher could be a limitation due to the fact that a dual role was held, both as researcher and employee of the host organization. This situation is referred to in the literature as an 'insider researcher' whose role is explored under three major research paradigms of positivism, hermeneutics and action research (Brannick & Coglan, 2007). Four

areas of concern that might be faced by an insider researcher - access, preunderstanding, role duality and organizational politics – were explored. It was concluded that insider research is valuable despite the traditional thinking that the researcher should be external so as to avoid bias and the risk to objectivity in analysis of the data gathered during the research. Furthermore, they assert that with appropriate reflexivity, "*insider research is not problematic in itself and is respectable research in whatever paradigm it is undertaken"* (Brannick & Coglan, 2007, p. 72). The disadvantage and potential bias of the researcher being an insider was in part balanced against the high degree of accessibility the researcher had to the employees and documentation of the host organization. This level of access is rarely available to external researchers; not necessarily because the organization is withholding information, but rather the researcher does not know the information exists and therefore does not request it. Organizational politics did not factor into the research as an issue because the organization had officially supported the research and the Regional Director of Pharmacy, as the organizational sponsor of the research, was very supportive of the work.

The transferability of the findings to other organizations is of concern particularly when the strategy of the host organization may be different than that of other organizations. As noted above, medication management is highly regulated so processes are developed to ensure compliance with regulations or evidence based practices increase the transferability of the findings. The transferability of the methodology and the tools used could be applied in other organizations or in other business areas within the host organization.

3.7 Summary

The methodology used in this research was based on a combination of deductive and inductive approaches. A selection of methods and techniques found in both qualitative and

quantitative methodologies were used. The research design was a ten step process that was undertaken in an organization that provides healthcare services in acute care hospitals, long term care facilities and community programs. The research included interviews of workshop participants and organizational leaders; therefore, ethics approval was required and included in the design. Data collection included both primary data and secondary data. Reliability, validity and generalizability of the results were considered in the context of trustworthiness and authenticity. The limitations of the research were also considered particularly from the aspect of the researcher being employed by the host organization during the research period.

The 8-step process followed in this research is summarized in Table 6.

Table 6 Simplified Outline of Process

Activity	Business Artefact	BPM Lifecycle Phase or BA Activity
Identify Strategic Business Objectives, Critical Success Factors, Key Performance/Process Indicators	Strategy Ma(Figure 2) Strategy Canvas and Performance Measures (Appendix 1)	BA Activity
Develop End-to-End process including core processes, management processes and support processes along with the Drivers/Influencers of the process	Value Chain (Figure 4)	Process Discovery
Identify Business Areas throughout the Organization that are involved in the End-to-End Process		BA Activity
Identify Business Competency Groups and Business Competencies related to the End-to-End Process	Business Competency Model (Figure 3)	BA Activity
Develop Listing of Processes based on Value Chain and Business Competency Model	Process Reference Model	BPM Activity
Identify Pain Points and potential improvement initiatives and develop future state End-to-End process if different than current As-Is process represented in Value		BPM Process Analysis
Rank Improvement Initiatives based on AHP approach	Ranked Improvement Initiatives (Table 5)	Process Analysis
Develop Improvement Plan based on Ranked Improvement Initiatives		Process Redesign

4 Results

The results of this research are presented in four sections followed by a summary. The first section provides the results of the development of the medication management business artefacts and the relationships between them using the BPMO. The second section provides an example of a process improvement project undertaken during the research period that utilized all phases of the BPM lifecycle. The third section provides the result of the thematic content analysis and summative content analysis of both sets of interviews. These results are presented based on the workshop participant interviews, organization leader interviews and analysis of language used in the responses from both sets of interviews. The fourth section is the proposed process reference model for medication management.

4.1 Business Artefacts

Although relationships are mainly defined at the level of meta-objects (e.g., in enterprise ontologies), the BPMO contains a set of archetypal relationships that have been observed to apply to almost any process related object and artefact. These relationships have been defined at the level of meta-object groups, which means that they apply to object groups in corporate ontologies, elicited using these meta-objects. The BPMO identifies sixteen meta-object groups. Although these groups contain meta-objects, they are not meta-objects. Their relationships with the process meta-object groups are summarized in Figure 7 which is an overview of these sixteen groups and how they relate to the process objects. These sixteen groups assemble composition meta-objects, which can be observed in several areas of business other than processes. Consequently, this template can be reused to represent the relations between these sixteen groups and other aspects of business (von Rosing et al., 2014).

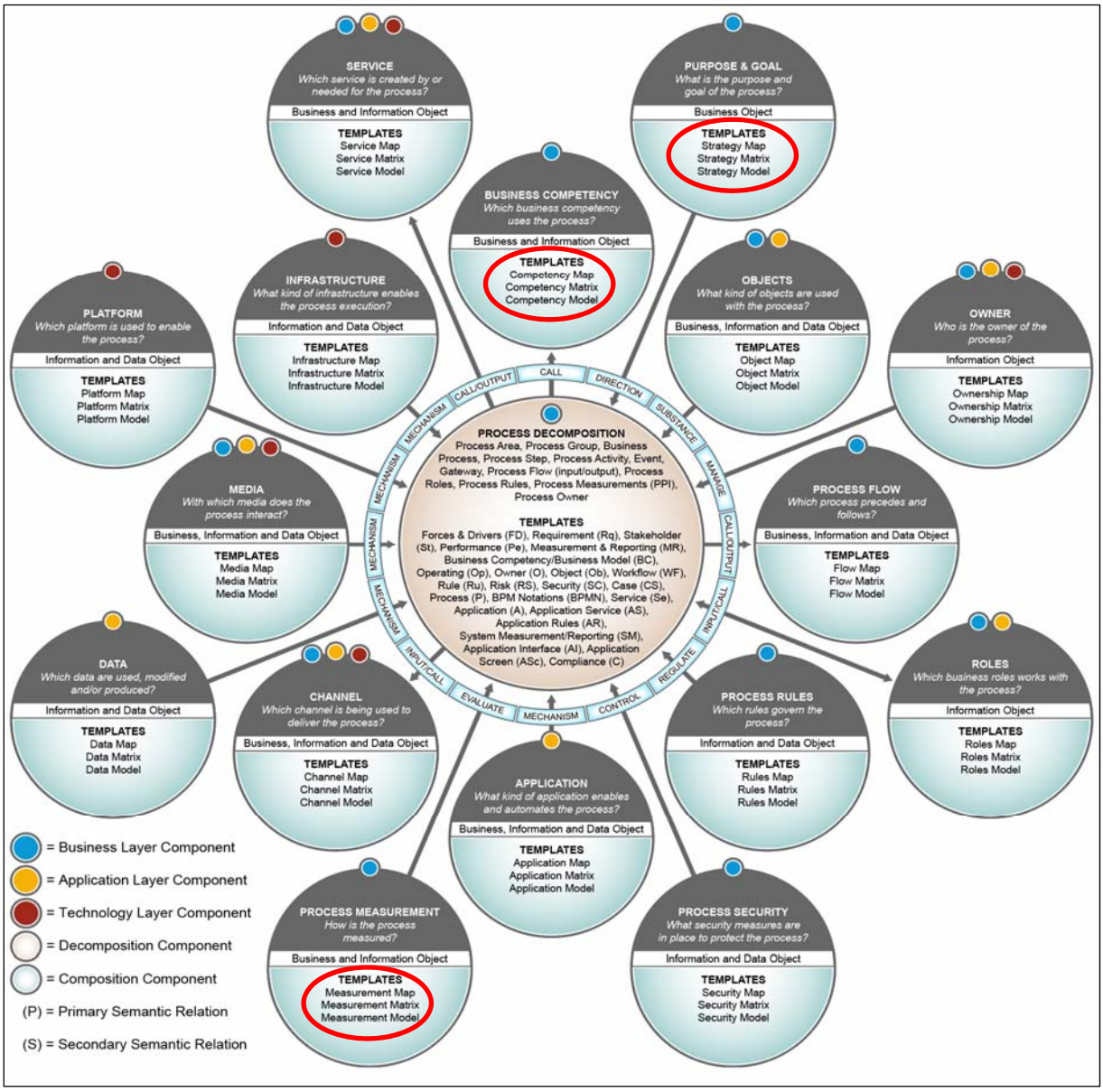


Figure 7 The 16 basic BPM Ontology process classes and groups where the examples applied are marked red (Source von Rosing, Scheer and von Scheel, 2015 page 107. Reproduced with permission.)

As illustrated in Figure 7, the process meta-objects do not only have relationships to the central concept of a Business Process, but also with multiple other groups. The specification of the various BPMO groups and artefact/template relationships provide an important tool to assess the details of the relationship between multiple concepts, as each object that belongs to one of these sixteen meta-object groups is expected to be related to any

business process object in order to obtain a complete business process specification (von Rosing et al., 2014). This approach is expected to provide a powerful tool to assist in the identification and capture of all relevant process aspects, providing an overview of how various concepts and artefacts relate to BPM. The following seven artefacts were key deliverables from the workshop and will be discussed further:

1. Strategy map
2. Strategy canvas
3. Business competency model
4. Value chain
5. Strategic action plan
6. Prioritized list of improvement initiatives
7. Performance monitoring plan.

The business artefacts were created based on LEADing Practice standards which have also been created based on the business ontology. The content was developed through consensus of the workshop participants. These business artefacts are specific to medication management and are aligned with the overall organization's BA based on the objects included in the BPMO. All business artefacts presented in this research were reviewed and accepted by the working group members as representative of medication management within the host organization.

There are several business artefacts that could have also been developed including: a Revenue Model, Cost Model, Process Governance Model, and Process Operating Model. The limited availability of workshop participants' time necessitated the selection of business artefacts for development that were critical to identifying quality improvement opportunities.

The seven business artefacts chosen were deemed most appropriate. The other relevant business artefacts that were developed but not presented in the results are the numerous medication management process models that are included in the process repository of the host organization. The results do include an example of one such model which is presented in section 4.1.

The business artefacts included cover the four sub-layers of the business layer of the layered enterprise architecture. In addition, the business artefacts for the strategic action plan and prioritization documents show how the objects within the business artefacts were used in the planning and scheduling of process improvements. Appendix 8 provides a visual representation of the business objects and how these objects are related to each other.

4.1.1 Strategy map and strategy canvas. The purpose of developing a strategy map for medication management was to identify the purpose and value of this service. It enabled alignment of objectives for medication management with the organization level objectives. The development of the strategy map also enabled consensus building on the strategic business objectives (SBOs), critical success factors (CSFs) and key performance indicators (KPIs) which are the objects included in the strategy map.

LEADing Practice describes SBOs, CSFs and KPIs in a Meta Object Taxonomy which they provide to certified practitioners. Unfortunately this document is not publicly available. SBOs are used to describe the strategy which is defined as "*The direction and ends which the enterprise seeks, as well as the means and methods by which these ends will be attained*". CSFs are described as "*Time bounded milestones to measure and gauge the progress towards a strategy or goal"*. KPIs are described as "*Any of a series of metrics used by an enterprise to indicate its overall ability to achieve its mission*". Table 7 is an excerpt of

Appendix 9 Strategy Map objects where the full listing of SBOs, CSFs and KPIs are shown. The strategy map shows the organization level SBO, the related medication management SBO, the CSFs associated with each SBO and the KPI(s) associated with each CSF. CSFs 2.1 and 2.2 do not have a KPI identified for them. The group acknowledged these are important objectives but remained uncertain on how they could be measured.

Table 7. Medication Management Strategy Map Excerpt

Organization SBO
Medication Management SBO(s)
Medication Management CSF(s)
Medication Management KPI(S)
Improve Clinical Outcomes
1.0 Improve Clinical Outcomes
1.1 Ensure medication reconciliation at all transitions in care
% of discrepancies (requiring intervention) found after/during medication reconciliation
% of patient with Medication Reconciliation completed within 24 hours of admission
% of Patients with Medication Reconciliation Completed at Discharge

Information from organizational level business artefacts was combined with medication management specific documents to develop a strategy canvas showing the relationships between the CSFs on the medication management strategy map and objects from the organizational level artefacts. This model shows the relationship between CSF and the following business objects:

- Organizational Business Area
- Medication Safety Working Groups
- 2016-2021 NH Strategic Plan Priorities
- NH Strategic Business Objectives

- Medication Management 3 year Strategic Action Plan Initiatives
- KPIs

Figure 8 is an excerpt of Appendix 10 Strategy Canvas for Medication Management

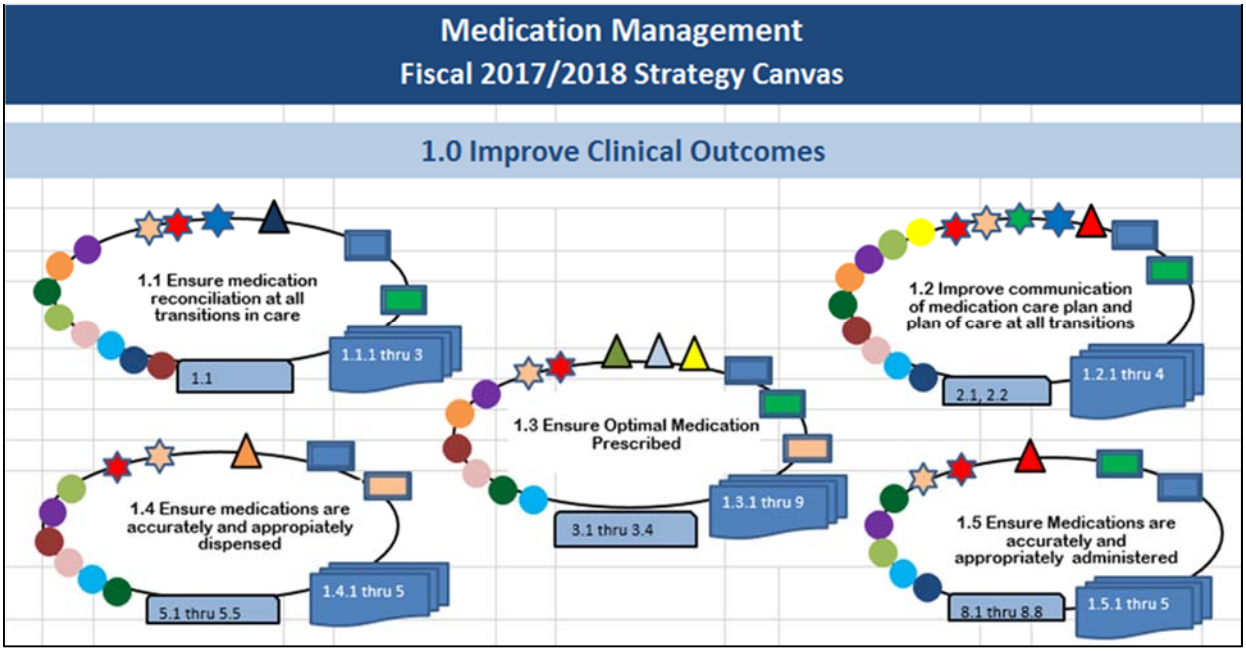


Figure 8. Excerpt from Medication Management Strategy Canvas

4.1.2 Business competency model. The purpose of developing the business competency model was to identify and document the business competencies (functions) required to deliver the value identified in the strategy map. The business competency model identified the business areas, the business competency groups within the business areas and the business functions required to provide medication management services. The business competency groups are shown in three accountability tiers: strategic, tactical and operational. The strategic tier includes functions related to governance and long term planning. The tactical tier includes functions associated with monitoring and controlling. The operational tier includes functions related to delivery of the service. A business competency model can

be developed for the entire organization, a single business area or a business service. The business competency model described below is specific to medication management services within the host organization. A business competency is defined as "*a firm's ability or capacity to turn its resources into customer value and profits*" (Rosenberg et al., 2011, p. 45). The term competency created some confusion among workshop participants as they struggled with delineating the 'business' competency from 'personal or clinical' competency. The term function was easier for the group to use so in this document the term 'competency' is interchangeable with the term 'function'. Similarly, the clinicians struggled with reference to 'business area' and preferred to use the term 'organizational area'.

The medication management business competency model represents a service that has processes executed in eight organizational areas. These include Pharmacy, Acute Care, Long Term Care, Home Support, Primary Care, Community Specialized Services, Public Health and Records Management. Appendix 11 shows the business competency 'map' which is a listing of the competency groups and functions. The map includes all functions within Pharmacy in addition to medication management functions in other organizational areas. Appendix 12 is the business competency model which uses the business competency map as the starting point.

In addition to distinguishing the competencies based on organizational area, the business competency model also includes rating of the maturity level of the underlying processes on the operational tier competencies and several of the tactical tier competencies. Due to time constraints not all competencies were assigned a maturity rating by the workshop participants. The maturity level was assigned based on a 1 to 5 ranking (von Rosing et al., 2014, pp. 408-420). The result was that most functions were assigned a very low maturity

level either 1 or 2 due to the variability in the processes underlying functions across sites. The maturity levels are described as:

- Level 1 - Typically process & procedures of a function are undocumented and in a state of dynamic change. Tends to be siloed, ad hoc, uncontrolled and chaotic
- Level 2 - Processes & procedures are repeatable, possibly with consistent results, discipline is unlikely to be rigorous.
- Level 3 - Defined and documented process & procedures for function are established and subject to some degree of improvement over time. Standards are in place and used to establish consistency of performance.
- Level 4 - Performance is measured and function can be effectively managed & controlled. Management can identify ways to adjust and adapt the function to meet requirements.
- Level 5 - Focus is on continuous improvement of performance, effectiveness & efficiency through both incremental and innovative changes with feedback & collaboration.

4.1.3 Value chain. A value chain provides a high level view of the functions and underlying processes that create value for the customer. The Medication Management Services value chain developed by the workshop participants includes four groupings of functions: the core functions are categorized as 1) Manage Medication at Point of Care, 2) Provide Clinical Training & Professional Development, 3) Manage Medication Supply Chain and 4) Manage & Administrate.

The medication management core functions include the seven steps showing the end-to-end process for a patient receiving medication therapy. These seven steps are: Patient

Registration, Patient Assessment, Prescribing, Point of Care Dispensing, Medication Administration, Patient Monitoring and Patient Discharge. The value chain is shown as linear, however, the process is iterative between Patient Assessment and Patient Monitoring based on patient response to medication therapy.

The three groups categorized as either support or management functions include: 1) medication supply chain functions, 2) provide clinical training & professional development, and 3) manage & administrate. Medication supply chain functions include: medication sourcing, inventory management, medication packaging/repackaging, medication distribution and medication returns. Provide clinical training & professional development functions include: provide pharmacy staff training, provide clinical pharmacy competency development, provide clinical education and manage clinical student placement. Manage and administrate functions include: planning, risk management, compliance management, contract management, human resource management, financial management, information management, procure and maintain equipment & facilities, and provide operational oversight.

The value chain also shows fifteen external influencers or drivers which are known to have an impact on how medication management services are organized, delivered and governed. Examples of influencers and drivers include; Community Partners, Labour Unions, Ministry of Health, Geography, Consumer Expectation, Legislation and Professional Regulatory Colleges. The medication management value chain is included as Appendix 13.

4.1.4 Strategic action plan. The host organization developed an operational plan with eight operational priorities one of which was medication safety and quality (Northern Health, 2016). The Regional Director of Pharmacy was identified as the process owner and responsible for the development of a three year strategic action plan to improve medication safety and quality throughout the organization. The initiatives identified were based on

selected critical success factors (CSFs) from the medication management strategy map. There were a total of twenty-nine initiatives identified based on the review of the end-to-end medication management process and the maturity levels of the core, management and support processes.

The strategic action plan business artefact showed the relationship of each of the twenty-nine initiatives to the Medication Management CSFs, and SBOs as well as the organizational level SBOs and CSFs. It also illustrated the alignment to one of the five Strategic Plan Priorities included in the 2016-2021 Strategic Plan. The KPIs from the respective medication management CSFs were included in addition to some specific process performance indicators (PPIs) depending on the initiative. The resource requirements to achieve the twenty-nine initiatives exceeded those available so there was a need to prioritize the initiatives. This was achieved by the prioritization working group based on criteria established by the workshop participants. The results of the analytical hierarchy process used to prioritize the initiatives are presented in the next section.

4.1.5 Prioritized improvement initiatives. The objective of the prioritization exercise was to develop a ranked listing of the improvement initiatives based on which initiatives would contribute the most benefit to medication management safety and quality. This was achieved as a three step process. The first step was to identify and define the appropriate criteria for comparison. The second step was to establish the weighting of the criteria. The third step was to rate each initiative against the criteria. The result was a ranked list of initiatives based on how well each initiative satisfied the criteria.

The workshop participants identified seven criteria to evaluate each of the initiatives. The seven criteria were 1) Business Continuity, 2) Feasibility, 3) Patient Safety, 4) Worker Safety, 5) Process Maturity, 6) Strategic Alignment and 7) Financial Impact. Criteria

questions and definitions were established to assist in creating a shared understanding of each of the criteria. Each of the criteria was explored from the perspective of questions related to that criteria. Appendix 14 provides a table showing the complete listing of the criteria, criteria questions and definition of each criteria.

The weighting of the criteria was achieved through a pairwise comparison of the criteria based on an AHP scoring approach shown in Table 8. This scoring approach and the excel template are based on an AHP example presented by Dr. Michael Cochrane from Value Function Analytics.[1] The approach used a one to nine scoring scale (Saaty T. L., 1980). When the criteria being scored was higher in value than the criteria it was being compared to, a value between 1 and 9 was assigned. When the criteria being compared was lower in value than the criteria it was being compared to, the reciprocal value was assigned.

Table 8. AHP Scoring Approach

Intensity of Value	Interpretation
1	Criteria being compared are of equal value
3	Criteria being ranked has a slightly higher value than the comparator criteria
5	Criteria being ranked has a strongly higher value than the comparator criteria
7	Criteria being ranked has a very strongly higher value than the comparator criteria
9	Criteria being ranked has an absolutely higher value than the comparator criteria
2,4,6,8	Intermediate scales between two adjacent judgements
Reciprocals	If the criteria being ranked has a lower value than the comparator criteria

Each of the criteria when compared to itself would have equal value and as a result was assigned a value of 1. When business continuity was compared to feasibility, the prioritization working group decided business continuity had a slightly higher value than feasibility and assigned a score of 3. When they compared business continuity to patient safety, they decided patient safety was of a higher value and assigned a score of 1/5 which

[1] available at https://www.youtube.com/watch?v=zsld4TQacBU

was the same score assigned to worker safety. When business continuity was compared with process maturity and strategic alignment, they assigned a score of 1/2 to each of those criteria as they determined business continuity was of a lower value. They determined financial impact was equal in value to business continuity and assigned a score of 1. This process was completed for each of the criteria. Table 9 shows the results of the pairwise comparison of all seven criteria and the resulting criteria weighting based on the AHP approach. Not surprising that the criteria of Patient Safety and Worker Safety were rated higher in value than the other five criteria at 29.5% and 28.9%, respectively.

Table 9. Pairwise Comparison of Criteria

Item Number	**Item Number**	1	2	3	4	5	6	7
	Item Description	Business Continuity	Feasibility	Patient Safety	Process Maturity	Strategic Alignment	Financial Impact	Worker safety
1	Business Continuity	1.00	3.00000	0.20000	0.50000	0.50000	1.00000	0.20000
2	Feasibility	0.33	1.00	0.14286	3.00000	0.20000	3.00000	0.33333
3	Patient Safety	5.00	7.00	1.00	5.00000	5.00000	5.00000	1.00000
4	Process Maturity	2.00	0.33	0.20	1.00	0.14286	0.14286	0.14286
5	Strategic Alignment	2.00	5.00	0.20	7.00	1.00	0.14286	0.14286
6	Financial Impact	1.00	0.33	0.20	7.00	7.00	1.00	0.20000
7	Worker safety	5.00	3.00	1.00	7.00	7.00	5.00	1.00
	Sum	16.33	19.67	2.94	30.50	20.84	15.29	3.02

STANDARDIZED MATRIX

		Business Continuity	Feasibility	Patient Safety	Process Maturity	Strategic Alignment	Financial Impact	Worker safety	**Weight**
1	Business Continuity	0.06	0.15	0.07	0.02	0.02	0.07	0.07	**6.5%**
2	Feasibility	0.02	0.05	0.05	0.10	0.01	0.20	0.11	**7.6%**
3	Patient Safety	0.31	0.36	0.34	0.16	0.24	0.33	0.33	**29.5%**
4	Process Maturity	0.12	0.02	0.07	0.03	0.01	0.01	0.05	**4.3%**
5	Strategic Alignment	0.12	0.25	0.07	0.23	0.05	0.01	0.05	**11.1%**
6	Financial Impact	0.06	0.02	0.07	0.23	0.34	0.07	0.07	**12.0%**
7	Worker safety	0.31	0.15	0.34	0.23	0.34	0.33	0.33	**28.9%**

This criteria weighting was included in the tool used to rank each of the improvement initiatives. The tool was developed in Microsoft Excel. The tool rated the initiative against each of the criteria on a 7 point scale of -3 to +3. If there was a negative impact anticipated, the initiative was given a rating of -3 and the maximum optimistic positive impact was rated as +3. If there was no or minimal impact based on the criteria, the initiative was rated as 0. Appendix 15 is a copy of the ranking tool used. The 7 point scale was used because it provided sufficient opportunity for respondents to distinguish and rate the improvement opportunities. A 5 point scale would have resulted in less variance in the rating between the initiatives. A larger scale required respondents to answer with more precision and in some cases information was not available to be able to provide the level of precision that would be required to respond in a reliable and consistent manner in respect to all initiatives. Appendix 16 provides the results of the ranking exercise. Of the twenty-nine initiatives seventeen were included in the ranking activity. The remaining twelve initiatives were not ranked because some had been completed, others were mandatory, and therefore excluded, and the remainder did not provide enough information to complete the exercise.

The ranked list was presented to the workshop participants at the final meeting. The participants thought the final list appeared reasonable with the exception of Medication Administration rating of 424.7 which ranked it 10th out of the seventeen initiatives. The workshop participant who raised this as an issue had not participated in the prioritization working group so was not as familiar with the process and the criteria as those who had participated. One of the participants addressed this concern by referring to the feasibility and financial impact criteria explaining that this initiative would require a financial cost and, in addition, it would necessitate a change in the practice of all front line nursing staff. This issue was also raised during the interviews and is discussed further in Chapter 5.

4.1.6 Performance monitoring plan. The workshop participants and the measurement working group developed a list of ninety-one KPIs and PPIs. The full list of measures is provided in Appendix 7. The majority of these measures are tactical, meaning they are intended to be used to monitor or control medication management processes and practices. Eighteen of the measures have been identified as appropriate for Executive level reporting. These are shown in Table 10.

Table 10. Medication Management Strategic Level Indicators

Executive Level Reporting
Currently Available
# of active order sets that are up to date
# of anti-infective Drug Therapy Problems resolved per inpatient admission
# of medication doses administered in error per PSLS resulting in harm level greater than or equal to level 3 harm
# of incident reports of staff exposure
% of VTE audits where patients received appropriate prophylaxis
% of patients with Medication Reconciliation Completed within 24 hours of admission
Average Length of Stay per acute inpatient admission
Cost of antimicrobials per 100 inpatient days
Defined Daily Dose (DDD) per 100 patient days for targeted antibiotic
Drug Costs per inpatient day
% of orders compliant with Safe Medication Order Writing (SMOW)
% of pharmacists who meet competency measures for clinical pharmacy
Not Yet Available
# of facilities meeting National Association of Pharmacy Regulatory Authorities (NAPRA) standards
% of patients with medication therapy plan documented as part of "care plan" (longitudinal plan)
% of Patients with Medication Reconciliation Completed at Discharge
% of patients with medication therapy plan documented as part of "plan of care" (episodic plan)
% of products with appropriate beyond use dating based on NAPRA standards
Total # of Resolved Drug Therapy Problems per quarter

The strategy map includes forty-eight of the ninety-one identified indicators and the strategic action plan includes sixty-one of the indicators. There is an overlap of twenty-seven indicators that appear on both the strategy map and the strategic action plan.

A review of availability of the indicators was undertaken and there are forty-three indicators currently available in electronic format with thirteen available from manual sources. During the research period, an internally developed application to collect clinical pharmacy related indicators was being trialed at the host organization. This application

provides values for an additional ten indicators on a fiscal period basis. The performance reporting is expected to include the sixty-six available indicators. The remaining twenty-five indicators will not be considered for reporting unless an efficient method can be developed to gather the information. Appendix 17 provides the anticipated reporting frequency of the sixty-six available indicators.

The performance monitoring report had not been developed but the future design will follow similar organizational reporting that provides indicators at the organizational level with the ability to drill down to specific facility indicators. Visualization will include statistical process control charts for each of the indicators at the organization wide level and at the facility level.

4.2 Example of Process Improvement Using BPM Lifecycle

The BPM lifecycle consists of six phases: 1) Process Identification and Opportunity Assessment, 2) Process Discovery (AS IS or Current State Process Mapping), 3) Process Analysis, 4) Process Re-design 5) Process Implementation and 6) Process Monitoring and Controlling. This research has covered phases one through three with limited activities in the remaining three phases. The process re-design and the process implementation phases were not completed due to time constraints and although a performance monitoring plan was developed it was not fully implemented. This work however did set the stage within the organization for others to explore opportunities at a detail level which employed BPM and demonstrated use of all six phases of the lifecycle.

4.2.1 Example. An example of this is a process improvement project that improved safety of medication administration for those medications administered through an infusion pump. A brief summary of that project is included to demonstrate the use of BPM and how

the selection of the initiative can be directly related back to the strategy map and business competency model presented above.

Process Identification & Opportunity Assessment: Process identification requires the systematic identification of processes in an organization. This example was restricted to a function within the medication management processes specific to the use of infusion pumps. The processes identified were those specific to the use of infusion pumps. Three processes were identified for opportunity assessment: 1) development of master drug library, 2) education of nurses on the use of the infusion pump and 3) administration of medication using an infusion pump. The opportunity identified and addressed was the education of nurses on the use of infusion pumps. The master drug library is intended to improve the safety of the administration of medications when using an infusion pump. The appropriate dosage and duration of the medication to be infused is pre-set in the software application of the infusion pump. The nurse is able to set the infusion pump based on pre-set dosage and duration or override it and manually program the infusion pump. The improvement undertaken was to increase the use of the master drug library as this would eliminate any risk of medication error related to programming either wrong dose or wrong duration. The initial project focused on one nursing unit that had an average of seven thousand seven hundred infusions per month with a compliance rate of 74%. There would be times for it to be appropriate for a nurse to override the master drug library and a target of 90% compliance was established.

Process Discovery: Current state mapping was undertaken to gain a better understanding of the current process used by nurses to administer medication using the infusion pumps. Current state mapping was also undertaken to explore the process used to

train nurses on the use of infusion pumps. Figure 9 provides a current state map of the infusion pump process.

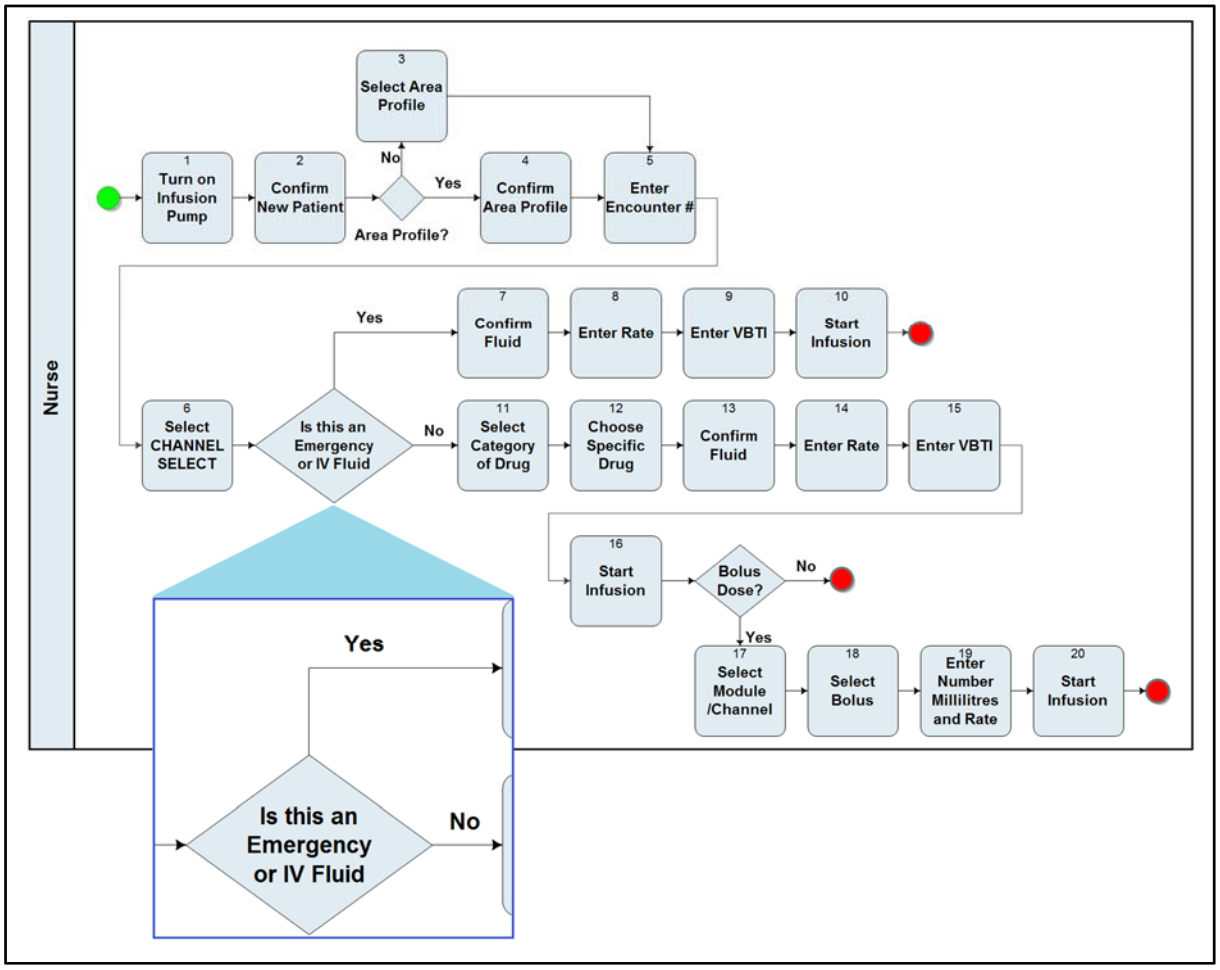


Figure 9 Current State Map Infusion Pumps

Process Analysis: Several activities were undertaken in this phase including interviews with nursing staff on why they were not using the master drug library and exploration of data available for monitoring the use of the master drug library. It was suggested that non-compliance may be associated with a specific set of medications but the data was not available to confirm or refute this theory. This phase revealed the main contributor to the non-compliance related to lack of adequate training on the use of infusion

pumps. There was a common practice among the nurses to select basic mode and bypass the use of medication drug library when IV fluid was to be used in delivery of the medication. Figure 9 shows where in the process this decision point occurred.

Process Redesign: The current process for training nurses on the infusion pump was revised and the future state process was developed. The future state process required revision of training material and incorporated an annual retesting step to ensure nurses maintained their skill level in using the infusion pumps. There was training provided and an immediate change was realized in practice related to IV Fluids and how to use the infusion pump. The decision point was changed to "is this an emergency" if yes bypass of medication drug library was appropriate if no use medication drug library.

Process Implementation: The new process for training nurses on the use of infusion pumps was implemented in the single unit where the project had been undertaken. Feedback from the nurses was used to revise and improve the training before it was implemented in other nursing units. This process has since become standard training across the organization.

Process Monitoring and Control: There are two aspects relevant to the process monitoring and control phase in this project. There is a report issued quarterly on the level of compliance with the use of the medication drug library during medication administration using the infusion pumps. There is a requirement for retraining of nurses practicing in units with low compliance. The results in the original nursing unit have shown an improvement in compliance from the initial 74.15% in January 2017 to 88.63% in December 2017. Figure 6 provides a process control chart that shows the monthly changes in this indicator.

This BPM project can be directly related to SBO 1.0 (Improve Clinical Outcomes), CSF 1.5 (Ensure Medications are Accurately & Appropriately Administered) and the KPI 1.5.2 (Percentage of IV medications infused through MDL (medication drug library)). The

researcher was the Executive Sponsor of this project providing guidance and oversight to the project lead.

4.3 Analysis of Interview Results

Semi-structured interviews were conducted with eleven of the twenty workshop participants and twenty-one of the seventy-three organizational leaders. The transcribed results were analyzed using NVIVO software and a content analysis approach (thematic and summative). There were a total of six themes identified between the two sets of interviews. These themes were explored through the lens of whether the respondent was identifying a challenge or a benefit within each of the themes. The six themes identified were Capacity Building, Communication, Collaboration, Competing Priorities, Connection to Strategy and Culture. The results of the analysis are presented individually for each of the interview groups followed by an analysis of the language used by survey respondents.

4.3.1 Workshop participant interviews.

The workshop participants engaged in a process to develop business artefacts expected to assist in the identification and prioritization of initiatives that would support improving the safety and quality of medication management within the host organization. There was a 55% response rate to the invitation to workshop participants with eleven of the twenty individuals invited agreeing to be interviewed. Participants included clinicians and non-clinicians engaged in either the management or support for front line staff responsible for the core processes and support processes associated with medication management in acute care and long term care facilities. The eleven

respondents had all been involved in either the workshops only or on the two working groups derived from the workshop participants.

4.3.1.1 Capacity building. The United Nations (2018) defines capacity building as *"the process of developing and strengthening the skills, instincts, processes and resources that organizations and communities need to survive, adapt and thrive in a fast-changing world."* Workshop participants expressed their perceptions of the benefits, potential benefits and challenges of implementing and using the three methodologies. Their responses included the use of the methodologies as well as the business artefacts. They also expressed interest in taking the work to the next phase of the BPM life cycle of process redesign and implementation.

Using the business artefacts as resources for others outside the workshop participants was seen to be a definite benefit. *"I learned a lot, and I think people coming in and looking at this work will be able to take bits and pieces or the whole thing and take it back to their sites and start working with what we have identified."* The documentation provided by the business artefacts was seen as contributing value both from facilitating improvement of the maturity levels of the processes and also from an organizational knowledge perspective. *"It (documented processes) would be a good review and a good teaching model to use with new staff."* "*The BPM, to me, gives you that higher level view and that along with the Business Architecture actually gives you a much richer picture of what you are dealing with.*"" *You need to understand the inner workings of that process in order to apply a solution, because I know from my past experience that applying an IT solution to a process that you don't know all of the details of, usually results in a more broken process."*

It was perceived very important to standardize medication management processes that are evidence based. The modeling of the "current as-is process" and of the "future state

process" is of benefit when establishing standardized processes. The need for standardized processes was a definite recurring desire. *"It's a pretty clear science. Pharmacy and medication management. It's not gray. I don't see why we wouldn't be standardized. The least amount of variation (in process) is better for patient safety". "If we standardize a process through nine different sites. Then one of the sites has an issue, we can highlight it and fix it for all the other sites. Along with that it's great for employees and staff that move from one site to another." "If you do not have standardized processes you run the risk of providing less than optimal care and unbalanced care… If you have totally different standards and systems then you run the risk of increasing errors and having decreased patient outcomes."" I believe medication management and the processes should be evidence based…and should reflect practices for all stakeholders that ensure the best outcomes for patients and are cost effective and to me standardization helps to fulfill that."* It was acknowledged that establishing standardized processes alone would not be enough. People would need to actually follow the established standard process and some suggestions were made on how this could be achieved. *"Having a documented process that people have to follow, if there's an understanding underneath it of why you're following that process, I think it makes things safer."" That's right it's got to be safe, and it's got to make sense, and it's got to be easy for people to do the right thing, and want to do the right thing. If it doesn't make sense, they either won't do it or they'll push back." "Yeah absolutely we need standard processes, and then within that, wherever it's possible have flexibility."*

Complexity and challenges with understanding the methodologies and the language was a theme expressed by workshop participants. *"I must admit, some of it I did feel like it was way over my head. I did try and read the documents ahead of time but I think you did a very good job of trying to lay it out for us and explain it for us." "So, one of the things I*

think people feel when they're first exposed to this is that they don't understand it and they don't understand it for a while."" And to compound that, another layer that sits on top of that, I think, is that I'm learning new concepts and I'm learning new language at the same time so I'm not saying, That's a dog. How do you say that in Cantonese?" One participant described the methodology as a *"bit of a brain teaser."* The AHP process was a challenge for at least one of the participants. "*Don't ever make me do that number thing again."*

4.3.1.2 Communication. Benefits of the documentation and business artefacts as a communication tool were frequently expressed. *"I think the documentation forms a review and that is the work you want to do and I think it helps with communicating out to staff clarifying roles and responsibilities and communicating what those are to staff." "So I think that's going to be the interesting part, is the translation from taking it from the mapping and all the work that we've done, how do we communicate that to the sites? Make it usable." "We have to document the process so that we can see where they're doing things that may introduce risk."*

4.3.1.3 Collaboration. The business artefacts support collaboration by identifying gaps which may not otherwise be visible within single silos. *"It's easy to work in silos and not realize where the gaps are." "Siloing between departments. It's a big one. Making sure the right information gets to the right person at the right time without overloading people." "The lack of understanding of why it's so important in one department to do it this way and so to follow through so it is a seamless system. That's a very high importance because there again if you don't have that seamless across the different continuums that's where you have your gaps and that's where you have your highest points of risk."*

Challenges identified with gaining collaboration included differences in interest level and lack of willingness to participate. *"Well, one, is just getting input from all the people*

that touch it, particularly when people don't necessarily see the importance or have an interest in it." "So the complexity of the med system is one that makes it challenging particularly when dealing with a large number of stakeholders and sometimes one stakeholder may not be able to have their own or all their interests met by making changes in the system."

4.3.1.4 Competing priorities. A potential benefit was identified related to establishment of the performance measurement plan. This provides information to support the selection and prioritization of improvement initiatives. *"As we continue to collect these metrics, we can try to figure out where we can get the most bang for our buck, like the best outcomes for the limited time and resources we have."*

The participants expressed a challenge concerning the competing priorities in respect to being able to complete this initiative in a fulsome and timely way. *"I don't feel like we have necessarily had the extra resources available to make it feasible." "It's very labor intensive and probably requires a lot of financial commitment in the organization to make significant change. "If you don't think these initiatives provide more value than the stuff you're doing currently, you're not going to spend time on them." "But maybe the fact that we did spread it out so having shorter sessions spread out was in respect to we all have other, we have main jobs to get back to, right, and if you dedicate a whole week to this you are not paying attention to your own job."*

4.3.1.5 Connection to strategy. Participants expressed their understanding of how BPM and the business artefacts were beneficial in assisting them in connecting their processes to strategy of the organization. *"I am thinking when you first document a process you are probably reviewing that process to ensure that process steps that you want to participate in to achieve your goals." "I think now that we have the metrics lined up to the*

actual strategic action plan, the strategy map, will help drive which ones we should be doing." "Make sure that we're meeting our goals, make sure we're efficient and not wasting time on other things like busy work."

The respondents did not indicate any challenges regarding connection to strategy. This may be related to the lack of representation from front line service delivery clinicians. Workshop participants were mainly drawn from management positions with some having limited responsibility to provide front line service.

4.3.1.6 Culture. The workshop participants who agreed to be interviewed made several comments that suggest the host organization could be described as a "learning organization" where people are willing to try new approaches to problem solving. *"I lacked the insight of what I didn't know at the time and I trust that the work that you are doing, like right off the bat, I trust that it was going to help us and it was going to work, even when I didn't quite understand it, because I respected you." "Hats off to you and your team for taking the complexity of it all and somehow, I call it your magic, being able to turn the concept into something practical and useful."*

The participants identified aspects of the culture they felt were challenges to improving medication safety. One of the most frequently mentioned aspects was accountability. *"Because when it's everybody's job, it's no one's responsibility." "I am not sure how good the follow up is and are they adhering to those standards. That's something we have to look at is really the accountability in the system." " There still seems to be this sense that a report (*referring to self-reporting of medication errors*) is going to get someone in trouble and that is one of the things getting in the way of people reporting."* Another aspect expressed related to risk tolerance. *"The quality piece is not being recognized in what people are doing. They are focusing on getting it done rather than doing it right."*

4.3.2 Organizational leader interviews. The organizational leaders have had varying degrees of exposure to BPM, BPMO and BA which was evident in the responses to the interview questions. This may also have contributed to the low response rate at 29% of those invited to participate. All those who were invited to participate had been involved in presentations of information based on the BA and BPMO; however, not all had been engaged or familiar with the BPM methodology. To date the use of the methodology had been limited within the organization. Despite the lack of familiarity, those who responded to the interview were able to recognize the challenges along with the benefits or potential benefits of using the methodologies within the organization.

4.3.2.1 Capacity building. The major theme identified was in the area of capacity building. Interviewees consistently referred to the value of the methodologies in increasing their understanding of their program area. This increased understanding and the reusability/transferability of the business artefacts are a potential valuable resource to the organization.

One of the most notable quotes that demonstrates this perspective was from a Program Director who had developed BA artefacts for his program areas and based his annual planning on the SBOs and CSFs "*I always kind of thought I knew the program but when you actually have to peel back the layers of the onion, so to speak, you know, you get all the aroma, you get your eyes stung out a little bit and it's the full feel, right. Versus basically picking up an onion, which was where I was at, and saying this is an onion "*. Likewise another leader who had used the approach to gain clarity on an initiative that was spread across several portfolios provided the following quote indicating the approach does increase organizational knowledge. *"So we were doing the work without knowing why we were doing the work and the process allowed us to identify why are we actually doing this*

work which allowed us to figure out what the strategic objectives are and the KPI's would be that made sense for that. And we had been spinning, thinking we knew what we were doing without really knowing what we were trying to accomplish." A third perspective was provided by a leader who had the opportunity to review business artefacts for a program within her portfolio including an end-to-end process model, strategy map and business competency model. *"It's that great visual to really identify where the barriers are, where the opportunities are and again to be able to go from high level down to the real micro level depending on the work that you're doing".* A fourth perspective addressed the potential benefits of the business artefacts. "*So I think once you get the basic documents, if you allowed yourself to continue to use them , you get incredible value looking then at certain aspects, like where are we mature, where are we not mature? Where are we spending money that we don't get value from? Where are we under resourcing? Where should we innovate, where should we standardize? Like I think the potential and I've seen elements of all those kinds of discussions going forward."* A leader provided the following succinct comment in reference to the value of the business artefacts. "*At their best they definitely help with planning and monitoring and evaluation and then can also inform the various clinical operational and organizational shifts that need to occur to carry out the process as it is mapped. So I think that, at their best, they can kind of really help the whole planning, implementation, and evaluation component."*

There were also challenges identified in the area of capacity building which included the complexity of such a comprehensive approach. This concern was raised both by those who had invested time using the approach and those who had only been involved at the periphery of the initiatives that used the methodologies. Examples of quotes that demonstrate the challenge related to complexity of the methodologies. *"I think it has to be*

still more intuitive to the different levels." "Unless I see what it (strategy map) looks like, because these things just confuse me". "I don't know if we've done a very good job of teaching people what it really means." I'll be frank with you, it makes me feel, not stupid, but it makes me feel challenged that I'm not able to understand. And I mean I have a graduate degree."

There were also suggestions on how the methodologies could be introduced so they were more understandable by the end user. These included suggestions to 'Fisher Price It' or 'Develop a BPM and BA 101'. "*I know that just in my former role how many times you guys came and in, it probably took second or third time of hearing it to really get it and so I don't need to be the knowledge expert in it, but a 101 on how to tap into the knowledge expert who can help me."* Several leaders also suggested it would be an improvement to separate the work from the methodology by using an information gathering approach without reference to the technical aspects of BPM, BPMO and BA. Their idea suggested an approach to gather the necessary detail so the Business Architects and Process Architects could develop the underlying detail and then share the information with the user groups in a simplified way that most participants would easily grasp. *"Instead of having the people, the subject experts learning another subject matter they're actually just able to spit out what they do and someone captures that because they understand the healthcare system and the business architecture."* There certainly was not consensus on this aspect as other leaders suggested they would require an increased understanding of the methodology before they would support the implementation in the organization or their portfolio.

4.3.2.2 Communication. The development of the business artefacts within the organization have been achieved by interviews and workshops with those directly involved in the business or service area the artefacts are intended to represent. This approach has

provided an excellent opportunity for increasing the communication both within program areas and across program areas.

Leaders interviewed commonly spoke of the value these interactions have had on the participants. One leader who had participated in the process modeling of the information request and report development process spoke of her personal experience. "*But had we not gone through that process of having the conversations and depicting it visually in front of people and what that looks like day to day work effort. We would not have gotten there just in conversation alone. I think it provides evidence but also provides a starting point for a much deeper conversation".* The business artefacts themselves have also been described as beneficial to enhancing communication. *"It was actually one day that in a Directors meeting with just coordinating it that we put up the business map (*Business Competency Model*) and we showed how many of us overlap and it definitely improved communication to know when to involve people in what."* One leader who had her group work with a Process Architect to develop a complete end-to-end process and use the BPMO to expand the process model to include competencies and risks in the clinical process described her thoughts on the benefits of the approach. *"It includes layers of information in a clear way and for me to be able to get to that level of detail with the chemo nursing has been probably the only way in which we've actually been able to fully articulate not only the process that the nurses follow but what competencies are needed and what risks there are if those competencies aren't there. So I think it's a really key communication piece, but it keeps you honest and it keeps us objective."* The same leader spoke to using the business artefact as a communication tool. "*The primary value of it for me is that it's my source of truth for communicating within my team as to how things work*."

The introduction of new terminology to the organization was a major challenge and a common theme in the leader responses. One leader in particular challenged the need for the terminology. "*And so why we're forcing terminology that people are clearly having trouble with is something we might need to clarify".* Another suggested that *"it needs to be thought through to not create a lot of unnecessary confusion."* Another leader stated *"I think one of the challenges is that if I take the overall end-to-end thing and I presented it to a Chief Operating Officer that is not going to work."*

These challenges with the terminology were also offset by at least one leader who thought the standardization of terminology was a definite benefit. *"So I think it helps us to have a common language that we can communicate in, Kind of a visual, but a kind of uniform way that now people are getting used to the different streams and they're using them to some degree."*

4.3.2.3 Collaboration. Healthcare services tend to be siloed and collaboration between business units is vital to developing and delivering services that are safe and effective for patients. Promoting collaboration requires the mutual engagement and understanding of the organization to recognize where duplications of effort and gaps in services exist for the patient. BPM and BA are effective in supporting collaboration.

Speaking specifically of the business competency models and the strategy maps at the program level, one leader expressed his thoughts on the benefit of the approach. *"The great thing too is if the program is one of those programs that touches upon or overlaps with say my department, then I can see where we can collaborate on, right."* When asked whether the methodologies helped identify improvement opportunities, a leader responded positively. *"Where I could see improvements is if you are doing one bit of things here that's assigned and there is another group doing similar things you can maybe say well let's try and see how*

we can consolidate the functions." Speaking specifically about the challenges of the current siloed approach to healthcare and the potential of these methodologies to identify opportunities for improvement one respondent commented: *"It takes resources, right and capacity to promote and align with other groups, because if we are just in our silos doing our own thing. And just where are the opportunities?"* There were no challenges identified in respect to how the use of the methodologies might negatively impact collaboration; however, there were challenges identified related to how to address the issue of collaboration when the methodology reveals the goals of one business area are seemingly in conflict with those of another business area.

4.3.2.4 Competing priorities. There are limited resources available and the time demands on human resources is a constant challenge. The use of these methodologies can support the prioritization of initiatives by identifying which processes are contributing more value than others. However, the development of the business artefacts does require focused time from operational leaders and clinicians.

The benefit of strategy mapping and clearly articulating the Critical Success Factors can support prioritization. A leader articulated this quite succinctly. *"So, it's been a challenge to respond to demand and without going through the strategy mapping process, I wouldn't be able to say no, I don't have the resources to do that. Maybe next year.*" Another benefit or potential benefit was expressed by a leader in respect to the knowledge gained from the identification of functions using the Business Competency Model. *"Because we have capacity issues everywhere and if we find that through this process we identify that our subject matter experts are spending 50% of their time on work that could be done by a centralized shop, whether it's place at HR or Finance, those kind of things, just there might be some efficiencies there".*

One leader specifically spoke to the time it takes to understand the methodology. "*I feel that I need time to be able to absorb, digest and use this and that in and of itself can also be a barrier for frontline staff and physicians who have all kinds of demands on their time*." This was reiterated by another leader who had explained why the process modeling she had started was not completed. "*I think we've just got a little bit more work to do, that piece of work for me has stalled just a tiny bit, not because of the mapping piece, but just because we had just a whole bunch of other things come up."*

4.3.2.5 Connection to strategy. One of the purported benefits of BA is that an organization can gain insight into the relationship between business objects. Specifically by combining the BPMO Ontology with BPM it is possible to show the relationship between processes and organizational strategy. Leaders who had been involved in the initiatives undertaken to date realized this as a benefit to the organization. In the words of one leader: *" so that's the really strong piece of the business architecture and that approach of looking at the process and saying which processes are actually delivering value to the organization".* In reference to the development of a strategy map at the portfolio level one leader made the following observation. "*We didn't really know what our strategic business objective was. We kind of did, so by identifying all that, now I can take all that work and say oh yes we are actually moving the yardsticks towards that objective that we're trying to achieve. So it was helpful."* One leader spoke about how the artefacts could be used to show front line staff how their work plan connected to the organization's five year Strategic Plan. *"The next steps would be once we have that work plan finally finalized, right and then we decide on what are the focus areas we're going to take on, then it's basic. Presenting it to the staff, to the internal staff and showing them. This is what has developed in terms of work plan this is how it all ties in and integrates with the Northern Health Strategic Plan."* Leaders who had been

active participants in the development of business artefacts were more likely to be able to make the connection between the business artefacts and the strategy of the organization.

4.3.2.6 Culture. The culture of an organization needs to be considered when implementing these methodologies. The degree to which an organization is considered to be a "learning organization" and whether there is a culture of "systems thinking" and commitment to quality, all contribute to the success of these methodologies. Leaders spoke to the organizational culture both from the perspective of the benefits of the current culture and also the challenges of implementing change.

The "learning organization" concepts were evident based on responses from several leaders within the organization indicating they would share their learning from their participation in using the methodologies with other leaders within the organization. "*And now I'm going to tell another Executive Lead this is what we did, and they'll be okay, they're going to start and so it's that use of it and that peer approach, peer promotion". "Because I have been lucky enough to be involved in the methodology for a couple of years now, I can speak to a certain extent, the language. And sometimes I think I can and should and do take the opportunity to try and explain it to my fellow clinicians in a way I think will make more sense to them. I think the other contribution I make, as a leader, I really value the methodology so I try to be a very good ambassador."* Willingness to accept the methodology has been mixed but for the most part those who have engaged expressed they did gain value from their participation as indicated in the previous sections.

Readiness of the culture within the organization to accept the new methodologies was expressed by another leader. He felt the recent introduction of Business Owner Working Groups charged with understanding the business functions and business requirements for technology solutions has set the organization on a good path to incorporate these

methodologies. *"Business Owner Working Groups, I think we need to be opportunistic because right now my read on the organization is that it is ready. That is like they've all done good work, I saw it in a recent all-day conference a couple of days ago, it's all right there, so it's low hanging fruit now to pick, organize and move it forward."*

There were also challenges to the introduction and acceptance of the methodologies with leaders citing cultural issues such as: a reactive approach vs a proactive approach, and ineffective planning processes. *"We're not going to get the big changes in healthcare that we need if we just keep tweaking". "I'm finding it really slow to get uptake actually because I don't know that we do much formal planning...We're still very reactive."*

4.3.3 Analysis of language used in survey responses. A word count query of the survey responses of leaders was compared to the survey responses of workshop participants. The top twenty words accounted for 22.57% of the words in leaders' responses and 21.83% of the words in workshop participant responses. Looking at the top twenty words in each query result showed that there were thirteen words or similar words on both sets of responses. Looking at the top ten words in each query result showed six words or similar words on both sets of responses. The top three words on responses from both sets of interviews were the same. Think (think, thinks, thinking) was number one with a weighted average of 3.1% by workshop participants and 2.88% by leaders. Process (process, processing, processed) was second on both sets of surveys with a weighted average of 2.02% by workshop participants and 1.42% by leaders. The third most frequent word used on both was like (like, liked, likely, likes) with a weighted average of 1.37% by workshop

participants and 1.33% by leaders. Table 11 provides a comparison of top twenty words in leaders responses compared to workshop participant responses.

Interestingly, the respondents' use of the word "think" could be interpreted as a benefit or a challenge. If respondents use the word "think" to indicate uncertainty then it could be perceived as a challenge since this usage indicated a lack of understanding of the concepts included in the management approaches introduced. On the other hand if the respondents used the word "think" to indicate these concepts are resulting in them revisiting their assumptions about how services are being delivered this then would definitely be considered a benefit. It is a benefit to any organization to have staff and managers think critically about the processes being followed unless the status quo is already producing excellent results and there is no change in the external environment. This is not the case in any sector and particularly not true in healthcare. There is room for improvement in the processes related to medication management as shown by the medication errors occurring and the cost of delivering the service.

Table 11. Word Count Comparison – Leaders and Workshop Participants

	Leaders	Workshop Participants
Word	**Weighted Percentage**	
think (think, thinks, thinking)	2.88	3.1
process (process, processes, processing)	1.42	2.02
like (like, likes)	1.33	1.37
working (worked, work, works, working)	1.31	1.08
business	1.26	
know (know, knows, knowing)	1.21	1.15
using (use, used, useful, using)	1.15	
right	1.1	0.82
just	1.06	1.03
one (one, ones)	1.06	0.98
people	0.95	1.04
need (need, needs, needed)	0.91	1.09
things (thing, things)	0.84	1.31
get	0.84	1.01
map (map, maps, mapped, mapping)	0.79	
really	0.79	0.68
model (model, models, modelled, modelling)	0.75	
going	0.74	
organization (organized, organizing, organize, organization)	0.73	
end (end, ended, ends)	0.71	
yeah		1.3
medications (medication, medications)		0.89
well		0.68
manager (manage, managed, management, manager, managers)		0.63
times (time, timely, timing, times)		0.86
efficient (efficient, efficiency, efficiencies)		0.69
make (make, makes, making)		0.84
Grand Total	21.83	22.57

There were twenty-three leaders interviewed, twelve had a clinical background and eleven had a business background. The management approach introduced is based on a collection of management, technology and quality improvement traditions as shown in Figure 2. Leaders with a business background would most likely have had exposure in their

education with components of all these traditions while clinical leaders would most likely have had minimal exposure to management and technology traditions in their clinical education. Therefore, it was important to determine whether or not this difference in foundational education between the two sub-groups would lead to a difference in words used in responses to the interview questions. An additional analysis was conducted to identify whether there was any evidence of a difference in responses based on foundational education of the respondents. The result of the top twenty words in each category of leader showed that the same eighteen words were in the top twenty words in the responses by both groups. This result does not provide any evidence that the difference existed. Table 12 shows the results of the comparison of the weighted average of the top twenty words between clinical leaders and business leaders.

Table 12. Word Comparison - Clinical and Business Leaders

	Clinical Leaders	Business Leaders
Word	**Weighted Percentage**	
think (think, thinks, thinking)	2.68	2.6
process (process, processes, processing)	1.57	1.4
like (like, likes)	1.43	1.26
business	1.36	1.69
right	1.25	1.26
using (use, used, useful, using)	1.17	1.21
one (one, ones)	1.17	0.89
know (know, knows, knowing)	1.1	1.15
just	1.01	1.07
working (worked, work, works, working)	0.99	1.37
people	0.88	0.84
end (end, ended, ends)	0.88	0.86
area (area, areas)	0.82	
get (get, gets, getting)	0.82	0.85
need (need, needs, needed)	0.81	0.89
map (map, maps, mapped, mapping)	0.75	0.82
organization (organized, organizing, organize, organization)	0.74	1.03
things (thing, things)	0.72	0.78
model model, models, modelled, modelling)	0.69	1.09
understanding (understand, understanding)	0.67	
artifacts (artifact, artifacts)		0.72
really		0.85
Grand Total	21.51	22.63

4.4 Medication Management Process Reference Model

To be useful, a process reference model for medication management should be generic enough for use as a starting point for the development of any health organization's process architecture. The proposed reference model for medication management resulting from this research used the process meta-objects of the BPMO described in section 3.2.6.1. The reference model created as part of this research includes one hundred and sixty-four individual processes categorized in four process areas and twenty-five process groups.

Process Area is defined as “the highest level of an abstract categorization of processes”. Process Group is defined as “a categorization and collection of processes into common groups”. Process is defined as “a set of structured activities or tasks with logical behaviour that produce a specific service or product” (Rosing, Scheer, & Scheel 2015, p.102). The process steps and process activities were not included in the process reference model as this level of detail is context specific at an organizational and/or department level and could be different for every organization.

Table 13 provides a comparison of LEAD process levels to APQC and SCOR process levels.

Table 13. Comparison of Different Views of Process Levels

Levels	APQC Process Classification Framework	LEAD Process Levels	SCOR (Supply Chain Operations Reference Model)
1	Category	Process Area	
2	Process Group	Process Group	Level 1
3	Process	Process	Level 2
4	Activity	Process Step	Level 3
5		Process Activity	Level 4

Adapted from Table 1 page 133 The Complete Business Handbook (von Rosing, Scheer & von Scheel, 2015)

A process can be categorized and tagged according to the role it fulfills within the organization. There are three types of processes including: 1) core (or main) processes, 2) supporting processes and 3) management processes. Process architectures including the process reference model are designed based on the process type.

The core (or main processes) are defined as those processes that provide a service. In the case of medication management this includes the processes provided at the point of care.

The individual roles involved in main processes are the clinicians and care providers that assess, diagnose, prescribe, dispense, administer, monitor and discharge patients.

The supporting processes support the delivery of the main processes. In the proposed reference model, the support processes are categorized into two areas depending on whether the processes were related to management of medication supply chain or provision of training and education. The recipients of training and education include both staff and external students who are placed in the organization as part of their formal education. A separate grouping of these processes was deemed appropriate since they could be considered to be either support or management processes depending on the recipient. The individual roles involved in support processes are the pharmacy staff with respect to medication supply chain and clinical pharmacist in respect to clinical education.

Management processes include administrative processes and the processes required to manage the core and support processes. The process reference model for medication management further categorizes these into nine groups based on the business function. The individual roles involved in management processes are the Regional Director, Pharmacy Managers, Anti-Microbial Stewardship Pharmacists, Drug Utilization Pharmacist and Administrative Assistants.

The Process Areas and the Process Groups used in the reference model were derived from the Value Chain described in section 4.1.3 and presented as Appendix 13. A total of four Process Areas were identified. These are: 1) Manage Medication at Point of Care, 2) Provide Clinical Training & Professional Development, 3) Manage Medication Supply Chain and 4) Manage & Administrate. In addition, a total of twenty-five Process Groups were identified Table 14.

Table 14 Process Areas & Process Groups

Areas	Groups
1. Manage Medication at Point of Care	
	1.1 Register Patient
	1.2 Assess Patient
	1.3 Prescribe Medication
	1.4 Dispense Medication at Point of Care
	1.5 Administer Medication
	1.6 Monitor Patient
	1.7 Transfer or Discharge Patient
2. Provide Clinical Training & Professional Development	
	2.1 Provide Pharmacy Staff Training
	2.2 Provide Clinical Pharmacy Competency Development
	2.3 Provide Clinical Education(External to Pharmacy)
	2.4 Manage Clinical Student Placement
3. Manage Medication Supply Chain	
	3.1 Source Medication
	3.2 Maintain Medication Inventory
	3.3 Mix & Repackage Medication
	3.4 Distribute Medication
	3.5 Return Medication
4. Manage & Administrate	
	4.1 Plan
	4.2 Manage Risk
	4.3 Monitor Compliance
	4.4 Manage Contracts
	4.5 Manage Human Resources
	4.6 Manage Financial Resources
	4.7 Manage Information
	4.8 Procure & Maintain Equipment & Facilities
	4.9 Provide Operational Oversight

Appendix 18 shows the Process Areas, Process Groups and the one hundred and sixty-four Processes included in the proposed process reference model. Each of the processes are associated with at least one business function. Appendix 19 provides a

definition of each business function included in the business competency model. The source of these definitions is an internal document of the host organization.

The identification of processes was achieved through review of the functions included on the Business Competency Model for Medication Management Services (Appendix 12). Each function was reviewed and the processes required to deliver the function were listed and included in the process reference model. A single function may require numerous processes to deliver it. Also, some processes can have a relationship with more than one function. An example of this is the process to "monitor training effectiveness". This process is related to more than one function because the functions are separated based on the recipient of the education. Figure 10 Relationship between Process Reference Model Meta-Objects and Business ArtefactsFigure 10 shows the relationship between the Medication Management Process Reference Model and the objects included on two business artefacts Value Chain and Business Competency Model.

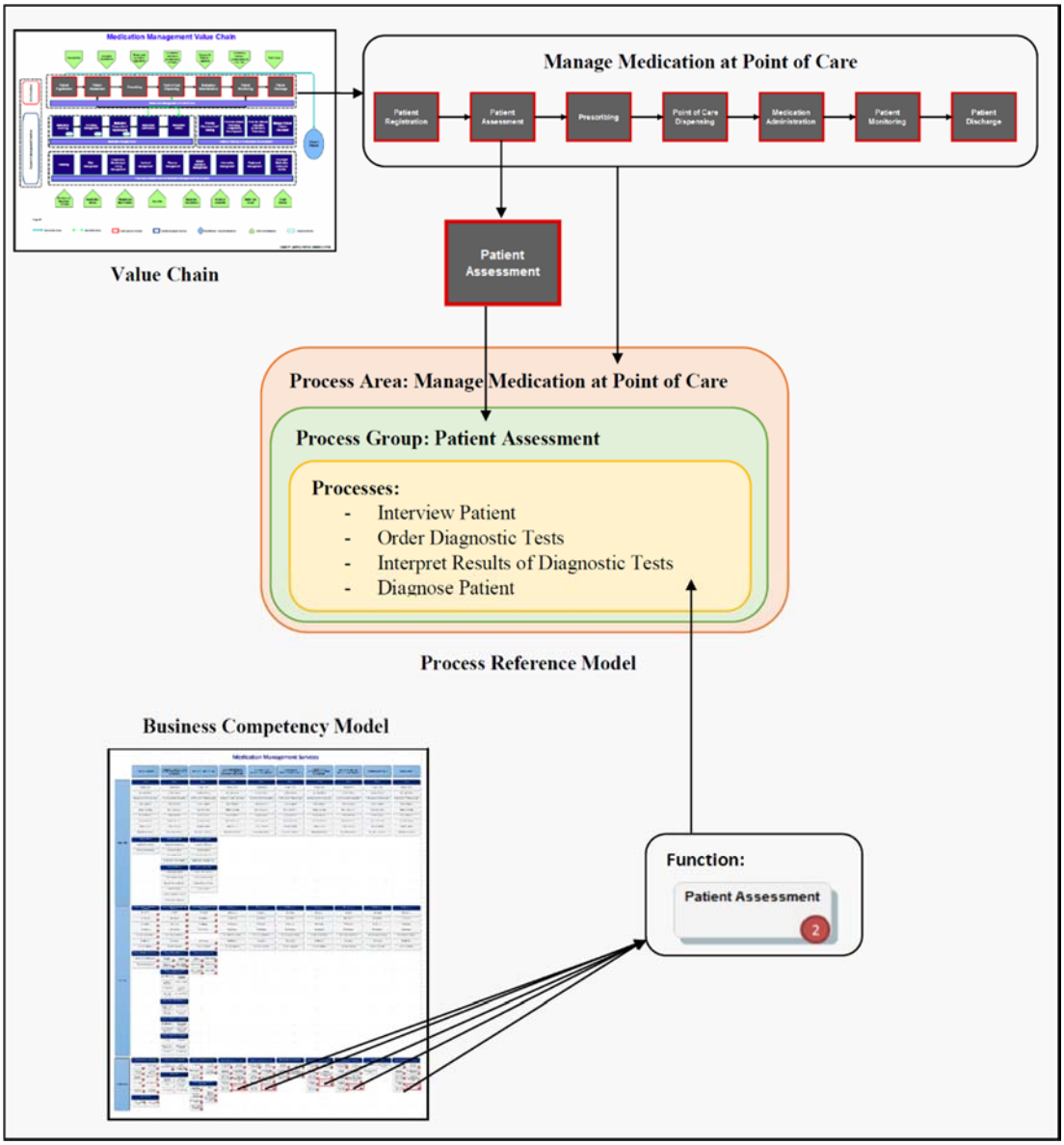


Figure 10 Relationship between Process Reference Model Meta-Objects and Business Artefacts

Two approaches were taken in an effort to validate the completeness of the process reference model. The first was to compare the listed processes to those listed in other relevant reference models. The second was to review the initial draft of the process reference model with the Regional Director of Pharmacy within the host organization. External validation of the process reference model was not undertaken.

Two relevant reference models were used for comparison: 1) SCOR reference model (Supply Chain Council Inc., 2012) and 2) the APQC (PCF) Process Classification Framework (American Productivity and Quality Centre (APQC), 2014). The reason these two were used was because these are both open source. In addition, the SCOR reference model could be closely aligned with the supply chain operations included in medication management and the APQC PCF was intended to be used by health care organizations.

The SCOR is specific to supply chain operations and as such was used in respect to the process area of Manage Medication Supply Chain. SCOR also includes management processes which were included in the Manage and Administrate process area. The processes included on the SCOR could be related to the processes in two process areas of the medication management reference model. The four groups of Source, Make, Deliver and Return from the SCOR model could be compared to the five groups on the medication management reference model of Source Medication, Maintain Medication Inventory, Mix & Repackage Medication, Distribute Medication and Return Medication. The remaining two groups from the SCOR specifically Plan and Enable could be compared to the nine groups in Manage & Administrate and three of the four groups under Provide Clinical Training & Professional Development on the medication management reference model. The seven process groups included in Manage Medication at Point of Care and one group from the Provide Clinical Training & Professional Development could not be compared to the SCOR model. Therefore it would appear that at the process group level all process groups from SCOR can be found on the medication management reference model. The additional groups included on the Management reference model are not supply chain specific so it is reasonable they would not be on the SCOR model.

APQC has developed numerous industry specific Process Classification Frameworks (PCF) including one related specifically to the provision of health care. This PCF does not differentiate pharmaceutical inventory management between centralized inventory or point of care inventory which have different processes and specific legislated considerations. Although it can be used as a general guide it was not specific enough for use as a medication management process reference model.

The Regional Director of Pharmacy reviewed and accepted the process reference model as a reasonable listing of the processes associated with medication management and safety. Additional validation with other workshop members was anticipated but was not undertaken prior to the completion of the research due to availability of workshop participants.

4.5 Summary of Results

Chapter 4 included results in four areas: 1) medication management business artefacts, 2) a completed BPM project in medication management, 3) thematic and summative content analysis of interviews and 4) a proposed process reference model for medication management. The comprehensive approach using BPM, BPMO and BA represented in this research has yielded some interesting results. Despite some challenges, both host organization participants and leaders acknowledge the benefits of the approach. The business artefacts represent foundational documents which could be valuable knowledge management and communication tools. They could help create a better understanding of how medication management could be viewed from the perspective of value, business competency and process. The AHP approach to prioritization of the improvement initiatives could be useful in any service area in the healthcare organization. Knowledge from the workshop and leader interviews could be used to modify and improve how BPM, BPMO and

BA are introduced in other healthcare organizations. The proposed Process Reference Model for Medication Management could be used by other healthcare organizations as they strive to understand the processes related to medication management or introduce BPM.

5 Discussion and Conclusion

The primary intention of this research was to expand on the current body of knowledge related to the introduction of a combination of BPM, BPMO and BA as a comprehensive management approach to improve operational processes in a complex adaptive system such as healthcare. This chapter consists of five sections which discuss findings and conclusions derived from the research undertaken. The first section discusses the impact of introducing three management disciplines; specifically, BPM, BPMO and BA in a healthcare organization. The second section discusses the proposed medication management Process Reference Model developed as part of this research. The third section discusses the perceived challenges and benefits of using these three management disciplines in the host organization. The fourth section presents the contribution of this research to the current body of knowledge and potential avenues for future research and finally, the fifth section provides concluding remarks on the research.

5.1 Integrating BPM, BPMO and BA in a Health Organization

BPM is a management discipline that has "process" as its focus and more specifically end-to-end processes which often span business units and even organizational boundaries. Medication management processes within a multi-facility healthcare organization were at the centre of this research. Understanding the processes associated with medication management and how those processes fit within the larger organizational context was explored, however, no attempt was made to investigate processes outside the organizational boundaries of the host organization. The established BPMO of LEADing Practice was employed to create a shared language related to the process objects. The business artefacts presented in Chapter 4 included objects related to the process level in addition to objects related to value, business

competency and services. The BPMO includes all these objects demonstrating it could be effectively and successfully applied to industries such as healthcare.

There were four significant impacts realized from the introduction of BPM, BPMO and BA in the host organization. The first was creation of knowledge assets in the form of business artefacts to support improvement of medication management in the organization. The second was the adoption of a common language that increases understanding across organizational areas and facilitates improved communication. The third was establishment of a repeatable process that would support creation of similar business artefacts in other organizational service areas. The fourth was the changed perspective of the individual participants which has led to their adoption of new approaches to service planning. This comprehensive approach has led to development of business artefacts that increase organizational knowledge which in turn results in an increase in organizational capacity previously discussed in section 4.3.2.1. In reference to research question 1, this research demonstrated how a business ontology used in other industries could be effectively applied to healthcare services.

5.2 Proposed Process Reference Model

Research question 2 asked what processes should be included in a process reference model for medication management applicable to both hospitals and long term care facilities. The proposed Process Reference Model uses the BPMO of LEADing Practice. It could be employed as a starting point in other healthcare organizations initiating a process architecture as it is based on medication management processes which are relatively standard across healthcare. The processes are derived from review of the medication management functions (business competencies) included in the Business Competency Model and these are then categorized into logical groups. The groups are then categorized into areas.

A common approach to developing a process architecture is to separate the processes into one of three types: core, support or management. These three types form Level 1 in the architecture. The BPMO refers to this level as an area. The reference model developed in this research has four areas: 1) Manage Medication at Point of Care, 2) Manage Medication Supply Chain, 3) Manage and Administrate and 4) Provide Clinical Training and Professional Development. The rationale for including the fourth area is the processes within Provide Clinical Training and Professional Development do not align with only one process type. There are processes within the area that could be considered to be support or management. The clinical nature of medication education and clinician's reliance on education being provided by clinical pharmacists warranted it as an area on its own. This area also includes a process group related to training of students and residents from academic institutions who complete practicums in the host organization facilities.

5.3 Challenges and Benefits

This section summarizes the perceived challenges and benefits of using BPM, BPMO and BA in a healthcare organization. It addresses three of the five research questions from Chapter 1.

3) What performance measurements in addition to medication errors are appropriate for monitoring and controlling medication management?
4) How can BPM be effectively applied to a situation that involves multiple sites and multiple business units responsible for Medication Management functions?
5) What are the benefits and challenges of using BPM and Business Ontology to improve Medication Management?

In response to question 3, the Measurement Working Group (MWG) identified ninety-one key performance indicators and process performance indicators they considered appropriate for monitoring and controlling medication management. The full listing is shown in Appendix 7. Examples of measures related to monitoring include measures of compliance with known procedural steps to prevent a medication error such as: "percentage of orders compliant with Safe Medication Order Writing Policy" and "percentage of medications infused through Medication Drug Library". Examples of measures related to controlling include: "cost of expired drugs" and "number of average turns of inventory". The MWG participants identified eighteen of these indicators that were thought to be relevant at the executive level given the relationship of those indicators to the current organizational strategy and directions. A listing of these indicators are provided in Table 10.

In response to question 4, it is the inclusion of BPMO and BA combined with BPM that enabled the adoption of BPM across the multiple sites and business units. Despite the challenges, the workshop participants developed business artefacts and a process architecture that incorporated all sites and business units within the host organization. The full lifecycle of BPM was not achieved in this research due to time constraints and availability of resources. However, implementation of BPMO and BA of medication management processes was achieved. Organization wide business artefacts were created and development of a process architecture for medication management was accomplished. Table 15 shows the stages of the BPM life cycle and comments on specific aspects achieved during the research period.

Table 15 Comments on Stages of BPM Lifecycle

Stage	Comments
Process Identification	Initial phase includes identifying processes and relationships which lead to development of a process architecture. In addition this phase includes identification of process performance measures. Both these objectives were achieved as shown by the Medication Management Process Reference Model and the Performance Management Plan
Process Discovery	Achieved through the development of current state 'as is' modeling using BPMN. Selected medication management processes prioritized for improvement have been modeled as part of this research.
Process Analysis	Achieved as shown by the ranking of maturity levels and identification of improvement initiatives. The prioritized list of initiatives is shown in the Appendix 16.
Process Redesign	Partially completed as described by the example provided in Chapter 4 and the design of a medication reconciliation process currently being implemented.
Process Implementation	Minimally with a few examples available where the process redesign was implemented including the process for training on the infusion pumps, development of medication order sets and process for establishing inventory levels.
Monitoring & Controlling	Minimally due to the challenges related to developing the collection mechanism for the metrics.

In response to question 5, results reported in Chapter 4 revealed organization leaders and workshop participants perceived both challenges and benefits in using BPM, BPMO and BA. The responses were themed into six categories: Capacity Building, Communication, Collaboration, Competing Priorities, Connection to Strategy and Culture. Some of the

identified challenges related to the concepts themselves while others related to the process used to introduce the concepts. One recurring concern was that the process followed was inadequately resourced resulting in a longer than ideal timeframe to complete the work. This was a legitimate challenge as all members of the working group were contributing to the work on an 'as time permitted basis'. However, for most participants it was seen to be a worthwhile undertaking and they were actively engaged in the development of business artefacts.

There were important lessons learned from introducing BPMO in the healthcare sector. The use of language, in other words, how the concepts related to BPMO are communicated, must resonate with those involved with the work. In this case, the use of terms such as 'competency' and 'business area' were not intuitively understood or accepted by clinicians in the host organization and became contentious. Further investigation revealed that healthcare clinicians in a publicly funded healthcare organization do not perceive themselves to be 'in business' which contributed to their resistance and reluctance to describe their clinical work as a 'business area'. Similarly, there is a significant focus in the clinical world on personal competency to safely and effectively deliver specific treatments or interventions.

Notwithstanding the issue with 'competency', there was no difficulty observed with the BPMO language related to the objects introduced from the other business layers. One example is the group's rapid adoption of the terms 'strategic business objective', 'critical success factor' and 'key performance indicator' including freely referring to these in the corresponding acronyms SBOs, CSFs and KPIs.

Worthy of note in assessing the benefits and challenges of this approach, was the emphasis placed on 'thinking' by both interview groups. The benefit of stimulating non-

traditional thinking and approaches in the health care sector was that the organization was able to achieve results and perspectives hitherto unattainable. Without this fundamental change in 'thinking' that this approach generated, it is doubtful that notable benefits would have been realized.

There are benefits both to the organization and to the workshop participants resulting from the research. The AHP approach to prioritize the identified improvement initiatives was effective and the process can be used in other organizational areas needing to prioritize improvement initiatives. The business artefacts can be reused for numerous purposes including employee orientation, monitoring of performance, alignment of activities to strategic objectives, business planning and other activities where organizational knowledge related to medication management is required. This research has built capacity within the organization and set the stage for future process improvements in medication management.

The research participants were provided with the opportunity to develop business artefacts and contribute their clinical knowledge to advance the information assets of the organization. The discussions and information sharing provided a rare opportunity to look at the clinical work from a different perspective.

5.4 Contribution and Future Research

There are three notable contributions arising from this research. The first relates to the increase in organizational knowledge and understanding of the medication management process within the host organization, the second is the development and documentation of a process reference model for medication management and the third is the demonstration that a comprehensive management approach combining BPM, BPMO and BA can be achieved in a healthcare organization. The fundamental catalyst in achieving these results was the stimulation of non-traditional thinking.

This research and non-traditional thinking has led to, and continues to support, transformative change in both individuals and the organization. It has been a journey of discovery for those involved in the research, it has armed them with a new language, new lines of communication and new vision to see their organization and how it functions. Healthcare has been slow to adopt new management practices and this holistic approach supports mindful and deliberate change. It provides powerful linkages between day to day work of the individuals on the front lines with the overall organization's strategies and goals. The recipients of healthcare services are the ultimate beneficiaries of improvements in the healthcare system.

Further research is recommended, specifically in the following two areas:

1) Expanding the breadth and depth of the use of this comprehensive management approach in healthcare. It is recommended that research be undertaken to:

- Test and validate the medication management process reference model in other organizations;
- Complete a longitudinal research study by repeating the interview process with organizational leaders in the host organization one year out and two years out to identify to what degree the potential benefits were realized and/or challenges overcome; and,
- Expand use of the comprehensive approach to other end-to-end healthcare processes.

2) Explore the challenges associated with clinicians viewing their practice from a business perspective.

5.5 Concluding Comments

Despite the challenges identified, the host organization has embraced the comprehensive management approach of using BPM, BPMO and BA to improve services. Process identification is currently underway in three other end-to-end processes within the host organization: 1) A redesign of home support services that will improve care to clients and more closely align home support services with primary care in the organization, 2) Design and implementation of a family practice twenty-five bed inpatient unit, and 3) Improvement and standardization of the inpatient registration process with the desired outcome of improving data quality and information flow.

On a personal note, I would say leading any organization through adoption of a comprehensive approach such as this is not for the fainthearted. The benefits however, far outweighed the challenges. I was provided with an exceptional opportunity to contribute to the body of knowledge related to transferring management approaches from other industries into the healthcare sector and at the same time increase the knowledge assets of the host organization.

References

Accreditation Canada. (2015). *Required Organizational Practices Handbook 2015.* Retrieved February 14, 2015, from www.accreditation-canada.ca: https://accreditation.ca/required-organizational-practices/

Almaney, A. (1974). Communication and the systems theory of organization. *Journal of Business Communication, 12*(1), 35-43.

American Productivity and Quality Centre (APQC). (2014). *Process classification framework (PCF) - Healthcare provider members excel version 6.1.0.* Retrieved November 2014, from www.apqc.org: www.apqc.org/knowledge-base/documents/apqc-process-classification-framework-pcf-healthcare-provider-members-excel

Antonacci, G., Calabrese, A., D'Ambrogio, A., Giglio, A., Intrigila, B., & Ghiron, N. L. (2016). A BPMN-based automated approach for the analysis of healthcare processes. *Enabling Technologies Infrastructure for Collaorative Enterprises (WETICE) 2016 IEEE 25th International Conference* (pp. 124-129). IEEE.

Armistead, C., & Machin, S. (1997). Implications of business process management for operations management. *International Journal of Operations & Production Management, 17*(9), 886-898.

Au-Yong-Oliveira, M., & Ferreira, J. J. (2014). What if colorful images beme more important than works? Visual representations as the basic building blocks of human communication and storytelling. *World Future Review, 6*(1), 48-54.

Baker, G. R., MacIntosh-Murray, A., Porcellato, C., Dionne, L., Stelmacovich, K., & Born, K. (2008). Jonkoping County Council . *High Performing Healthcare System: Delivering Quality by Design*, 121-144.

Baker, G. R., Norton, P. G., Flintoft, V., Blais, R., Brown, A., Cox, J., . . . Tamblyn, R. (2004). The Canadian Adverse Events Study: the incidence of adverse events among hospital patients in Canada. *Canadian Medical Association Journal, 170*(11), 1678-1686. doi:https://doi.org/10.1503/cmaj.1040498

Bandara, W., Chand, D., Chircu, A., Hintringer, S., & Karagiannis, S. (2010). Business process management education in academia: Status, challenges and recommendations. *Communications of the Association for Information Systems, 27*(41).

Begun, J. W., Zimmerman, B., & Dooley, K. (2003). *Advances in health care organization theory.* (S. M. Mick, & M. Wyttenbach, Eds.) San Francisco: Jossey-Bass.

Bell, D. S., Cretin, S., Marken, R. S., & Landman, A. B. (2004). A conceptual framework for evaluating outpatient electronic prescribing systems based on their functional capabilities. *Journal of american Informatics Association, 11*(2), 60-70.

Bell, D. S., Crosson, A. J., Guinan, J. P., Wu, S., Pevnick, J. M., Wang, S. J., . . . Newberry, S. J. (2007). Pilot testing of electronic prescribing standards. *Agency for Healthcare Research and Quality*.

Bender, D., & Sartipi, K. (2013). HL7 & FIHR: An Agile and RESTful approach to healthcare information Exchange. *Computer-Based Medical Systems 2013 26th International Symposium* (pp. 326-331). IEEE.

Benneyan, J. C., Lloyd, R. C., & Plesk, P. G. (2003). Statistical process control as a tool for research and healthcare improvement. *BMJ Quality and Safety, 12*(6), 458-464.

Bepko, R. J., Moore, J. R., & Coleman, J. R. (2009). Implementation of a pharmacy automation system (Robotics) to ensure medication safety at Norwalk Hospital. *Quality Management in Health Care, 18*(2), 103-114.

Beuscart-Zephir, M. C., Pelayo, S., & Bernonville, S. (2010). Example of a human factors engineering approach to a medication administration work system: Potential impact on patient safety. *International Journal of Medical Informatics, 79*(4), 343-357.

Biazzo, S. (2002). Process mapping tecniques and organizational analysis. Lessons from sociotechnical system theory. *Business Process Management Journal, 8*(1), 42-52.

Blobel, B., Goossen, W., & Brochhausen, M. (2014). Clinical modeling-a critical analysis. *International journal of medical informatics, 83*(1), 57-69.

Brannick, T., & Coglan, D. (2007, January). In Defense of Being "Native" The Case for Insider Academic Research. *Organizational Research Methods, 10*(1), 59-74. doi:10.1177/1094428106289253

Brennan, T. A., Leape, L. L., Laird, N. M., Hebert, L., Localio, A. R., Lawthers, A. G., . . . Hiatt, H. H. (1991). Incidence of adverse events and negligence in hospitalized

patients. Results of the Harvard medical practice study 1. *New England Journal of Medicine, 324*(6), 370-377.

Brown, T. (2004). *The Value of Enterprise Architecture.* Retrieved January 17, 2016, from https//www:eacoe.org.

Bryman, A., Bell, E., Mills, A. J., & Yue, A. R. (2011). *Business Research Methods.* Oxford University Press.

Business Architecture Guild. (2017). *A Guide to the business architecture bondy of knowledge.* Retrieved April 2017, from www.businessarchitectureguild.org: www.businessarchitectureguild.org/resource/resmgr/BIZBOK_5.5_Part1_FINAL.pdf

Business Process Management Institute. (2016). *What is BPM anyway? Business process management explained*. Retrieved April 2017, from www.BPMInsitute.org: http://www.bpminstitute.org/resources/articles/what-bpm-anyway-business-process-management-explained

Canadian Foundation for Healthcare Improvement. (2011). *A comparative study of three transformative healthcare systems: Lessons for Canada.* Retrieved September 25, 2014, from http://www.cfhi-fcass.ca/SearchResultsNews/11-10-26/0d3e9041-a834-4511-9f95-7c37ba287a79.aspx

Chen, Y., & Tsai, M. (2014). An RFID solution for enhancing inpatient medication safety with real-time verifiable grouping-proof. *International Journal of Medical Informatics, 83*(1), 70-81.

Chircu, A. M., Gogan, J. L., Boss, S. R., & Baxter, R. (2013). Medication errors, handoff processes, and information quality. *Business Process Management Journal, 19*(2), 201-216.

Classen, D. C., & Metzger, J. (2003). Improving medication safety and the measurement conundrum and where to start. *International Journal for quality in Health Care, 15(suppl-1)*, i41-i47.

College of Registered Nurses of British Columbia. (2014). *Legislation relevant to nurses' practice*. Retrieved February 15, 2015, from www.crnbc.ca: www.crnbc.ca/standards

College of Registered Nurses of British Columbia. (2015). *Practice Standards*. Retrieved February 15, 2015, from www.crnbc.ca/standards: www.crnbc.ca/standards

College of Registered Nurses of British Columbia. (2016). *Medication Administration.* Retrieved July 2016, from www.crnbc.ca: www.crnbc.ca/standards/PractuceStandards/Pages/medicationadmin

Creswell, J. (2014). *Research Design Qualitiative, Quantitative, and Mixed Methods Approaches.* Los Angeles CA: Sage.

Cullen, D. J., Bates, D. W., Small, S. D., Cooper, S. D., Cooper, J. B., Nemeskal, A. R., & Leape, L. L. (1995). The incident reporting system does not detect adverse drug events: A problem for quality improvement. *The Joint Commission Journal on quality improvement, 21*(10), 541-548.

Davenport, T. H., & Beers, M. C. (1995). Managing information about processes. *Journal of Management Information Systems, 12*(1), 57-80.

Dugan, L. (2014). Exploiting business architecture for process excellence. In N. Palmer, P. Schooff, L. Dugan, C. Farina, C. Roledo, F. Kowalkowski, . . . K. Swenson, & L. Fischer (Ed.), *Passports to Success in BPM. Real World Theory and Application* (pp. 71-82). Future Strategies Inc.

Dumas, M., La Rosa, M., Mendling, J., & Reijers, H. A. (2013). *Fundamentals of Business Process Management.* Berlin: Springer-Verlag.

Elliott, M., & Liu, Y. (2010). The nine rights of medication administration: an overview. *British Journal of Nursing, 19*(5), 300-305.

Fernandes, O., Gorman, S. K., Slavik, R. S., Semchuk, W. M., Shalansky, S., Brussieres, J., . . . Toombs, K. (2015). Development of clinical pharmacy key performance indicaors for hospital pharmacists using a modified Delphi approach. *Annals of Pharmacotherapy, 49*(6), 656-669.

Forester, A., Halil, R. B., & Tierney, M. G. (2004, July). Pharmacist Surveillance of Adverse Events. *American Journal of Health System Phaarmacy, 61*, 1466-1472.

Gemmel, P., Vamdaele, D., & Tambeur, W. (2008). Hospital process orientation (HPO) the development of a measurement tool. *Total Quality Management & Business Excellence, 19*(12), 1207-1217.

Gharajedaghi, J. (2011). *Systems thinking: Managing chaos and complexity. A Platform for designing business architecture.* Elsevier.

Giaretta, P., & Guarino, N. (1995). Ontologies and knowledge bases towards a terminological clarification. *Towards very large knowlege bases : knowledge building & knowledge sharing, 25*(32), 307-317.

Green, J., & Thorgood, N. (2004). *Qualitative Methods for Health Research.* Thousand Oaks, CA: Sage.

Gregory, A. J. (2007). A systems perspective on control and performance measurement. *the Journal of hte Operational Research Society, 58*(11), 1503-1517.

Gruber, T. R. (1993). A translation approach to portable ontology specifications. *Knowledge Acquisition, 5*(2), 199-220.

Guarino, N. (1998). *Formal ontology and informtion systems* (Vol. 46). Trento, Italy: IOS press.

Guba, E. (1985). *The contet of emergent paradigm research.* (Y. S. Lincoln, Ed.) Beverly Hills, CA: Sage.

Haghighathoseini, A., Bobarshad, H., Saghafi, F., Rezaei, M. S., & Bagherzadeh, N. (2018). Hospital enterprise Architecture Framework (Study of Iranian University Hospital Organization). *International Journal of Medical Informatics, 114*, 88-100.

Hammer, M. (2010). What is business process management? In J. Vom Brocke, & M. Rosemann, *Handbook on Business Process Management 1, Introduction Methods and Information Systems* (pp. 3-16). Heidelberg: Springer. doi:101007/978-3-642-00416-2

Harmon, P. (2014). *Business Process Change: A Business Process Management Guide for Managers and Process Professionals.* Morgan Kaufmann.

Health Level Seven International. (2015). *About HL&*. Retrieved January 2016, from www.hl7.org: http://www.hl7.org

Helfert, M. (2009). Challentes of business process management in healthcare. Experience in the Irish healthcare sector. *Business Process Management Journal, 15*(6), 937-952.

iGrafx. (2013). *iGrafx and LEADing Practice announce strategic partnership, raising the bar by setting new standards ni Business Process Modeling.* Retrieved May 2017, from http://igrafx.com: www.igrafx.com/company/news/article

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mied methods research: A research paradigm whose time has come. *Educational Researcher*, 14-26.

Kang, D., Lee, J., Choi, S., & Kim, K. (2010). An ontology-based enterprise architecture. *Expert Systems with Applications, 37*(2), 1456-1464.

Kaplan, R. S., & Norton, D. P. (1992). the balanced scorecard - Measures that drive performance. *Harvard Business Review, 70*(1), 71-79.

Kappelman, L. A., & Zachman, J. A. (2013). The enterprise and its architecture: Ontology & challenges. *Journal of Computer Information Systems, 53*(4), 87-95. doi:10.1080/08874417.2013.11645654

Keers, R. N., Williams, S. D., Cooke, J., & Ashcroft, D. M. (2013). Causes of medication administration errors in hospitals: a systematic review of quantitative and qualitative evidence. *Drug Safety, 36*(11), 1045-1067.

Keers, R. N., Williams, S. D., Cooke, J., Walsh, T., & Ashcroft, D. M. (2014). Impact of interventions designed to reduce medication administration errors in hospitals: a systematic review. *Drug Safety, 37*(11), 1045-1067.

Keohane, C. A., Bane, A. D., Featherstone, E., Hayes, J., Woolf, S., Hurley, A., . . . Poon, E. G. (2008). Quantifying nursing workflow in medication administration. *the Journal of Nursing Administration, 38*(1), 19-26.

Khan, R. N. (2004). *Business Process Management: A Practical Guide.* Tampa, Florida: Megan-Kiffer.

Khorasai, S., & Almasifard, M. (2017). Evolution of Management Theory within 20 Century: A Systemic Overview of Paradigm Shifts in Management. *International Review of Management and Marketing, 7*(3), 134-137.

Kitson, N. A., Price, M., Lau, F., & Showler, G. (2013). Developing a medication communication framework across continuums of care using the Circle of Care Modeling approach. *BMC Health Services Research, 13*(418).

Kowalski, F. F. (2014). Using analytics to identify proess opportuities. In N. Palmer, P. Schoff, L. Dugan, C. Farina, P. Roledo, F. Kowalkowski, . . . K. Swenson, *Passports to Success in BPM Real World Theory and Application* (pp. 83-86). Future Strategies Inc.

Lacerda, D. P., Cassel, R. A., & Rodrigues, L. H. (2010). Service proess analysis using process engineering and the theory of constraints thinkig process. *Business Process Management Journal, 16*(2), 264-281.

Langley, G. J., Moen, R. D., Nolan, K. M., Nolan, T. W., Norman, C. L., & Provost, L. P. (2009). *The Improvement Guide A Practical Approach to Enhancing Organizational Performance.* John Wiley & Sons.

Leape, L. L., Bates, D. W., Cullen, D. J., Cooper, J., Demonaco, J. J., Gallivan, T., . . . Vander Vliet, M. (1995). System analysis of adverse drug events. *The Journal of the American Medical Association, 274*(1), 35-43.

Liu, W., Manias, E., & Gerdtz, M. (2011). Understanding medication safety i healthcare settings: a critical review of conceptual models. *Nursing Inquiry, 18*(4), 290-302.

Looy, A. V., Backer, M. D., & Poels, G. (2014). A conceptual framework and classification of capability areas for business process maturity. *Enterprise Information Systems, 8*(2), 188-224.

Maddern, H., Smart, P. A., Maull, R. S., & Childe, S. (2014). End-to-end process management: implications for theory and practice. *Production Planning & control, 25-16*, 1303-1321.

Manias, E. (2010). Medication communication a concept analysis. *Journal of Advanced Nursing, 66*(4), 933-943.

Margherita. (2014). Business process management system and activities two integrateve definitions to build an operational body of knowledge. *Business Process Management Journal, 20*(5), 642-662. doi:1011108/BPMJ-04-2013-0050

Martins, A. C., Giordani, F., & Rozenfeld , S. (2014). Adverse Drug Events among adult inpatients: a meta analysis of observational studies. *Journal of Clinical Pharmacy Therapeutics, 39*, 609-620.

Melao, N., & Pidd, M. (2000). A conceptual framework for understanding business process and business process modelling. *Information Systems Journal, 10*(2), 105-129.

Mertens, S., Gailly, F., & Poels, G. (2015). Supporting and assisting the execution of flexible healthcare process. *Proceedings of the 9th International Conference on Pervasive Computing Technologies for Healthcare* (pp. 334-337). ICSTInstitute for Computer Sciences Social-Informations and Telecommunications Engineering.

Montesi, G., & Lechi, A. (2009). Prevention of medication errors: detection and audit. *British Journal of clinical Pharmacology, 67*(6), 651-655.

Munstermann, B., Eckhardt, A., & Weitzel, T. (2010). The performance impact of business process standardization: An empirical evaluation of the recrutiment process. *Business Process Management Journal, 16*(1), 29-56.

Mykityshyn, M. G., & Rouse, W. B. (2007). Supporting strategic enterprise processes: An analysis of various architectural frameworks. *Informtion Knowledge Systems Management, 6*(1,2), 145-175.

National Coordinating Council for Medication Error Reporting and Prevention. (2017). *Reducing Medication Errors Associated with At-risk Behaviours by Healthcare Professionals.* doi:https://www.nccmerp.org/about-medication-errors

National Coordinating Council for Medication Error Reporting and Prevention. (2017). *What is a Medication Error?* Retrieved May 2017, from www.nccmerp.org: https://www.nccmerp.org/about-medication-errors

Niehaves, B., Plattfaut, R., & Becker, J. (2010). Does your business process management (still) fit the market? A dynamic capability perspective on BPM strategy development. *AMCIS*, (p. 292). doi:http://aisel.aisnet.org/amcis2010/292

Niehaves, B., Poeppelbuss, J., Plattfaut, R., & Becker, J. (2014). BPM capability development-a matter of contingencies. *Business Proceess Management Journal, 20*(1), 90-106.

Nigam, R., MacKinnon, N. J., David, U., Hartnell, N. R., Levy, A. R., Gurnham, M. E., & Nguyen, T. T. (2008). Development of Canadian safety indicators for medication use. *Healthcare Quarterly, 11*(sp), 47-53.

Object Management Group. (2014). *OMG and LEAding Practice Enter Into a Strategic Partnership*. Retrieved May 2017, from www.omg.org: www.p,g.org/news/releases/pr2014/0-29-14.htm

O'Cathain, A., Murphy, E., & Nicholl, J. (2007). Why, and how, mixed methods research is undertaken in health services research in England: A mixed methods study. *BMC Helath Services Research, 7*(85). doi:10.1186/1472-6963-7-85

O'Leary, D. E. (2010). Enterprise ontologies: Review and an activity theory approach. *International Journal of Accounting Information Systems, 11*(4), 336-352.

Pajik, D., Indihar-Stemberger, M., & Kovacic, A. (2012). Reference model design: An approach and its application. *IEEE*, (pp. 455-460).

Palmer, N., Schooff, P., Duga, L., Farina, C., Roledo, P., Kowalkowski, F., . . . Swenson, K. (2014). *Passports to Success in BPM Real World Theory and Application.* Future Strategies Inc.

Peters, D. H. (2014). The application of systems thinking in health: why use systems thinking? *Health Research Policy and Systems, 12*(1), 51.

Pham, J. C., Aswani, M. S., Rosen, M., Lee, H. W., Huddle, M., Weeks, K., & Pronovost, P. J. (2012). Reducing medical errors and adverse events. *Annual Review of Medicine, 63*, 447-463.

Ponsignon, F., Smart, P., & Maull, R. (2012). Process design principles in service firms: Universal or context dependent? A literature review and new research directions. *23*(11), 1273-1296.

Poon, E. G., Keohane, C. A., Yoon, C. S., Ditmore, M., Bane, A., Levtizon-Korach, O., . . . Gandhi, T. K. (2010). Effect of Bar-code technology on the safety of medication administration. *The New England Journal of Medicine, 362*(18), 1698-1707.

Qian, S., & Yu, P. (2013). Model medication management process in Australian nursing home using business process modeling. *Studies in Health Technology and Informatics, 192*(1061).

Reason, J. (2000). Human error: models and management. *BMJ, 7237*(2000), 768-770.

Redley, B., & Botti, M. (2013). Reported medication errors after introducing an electronic medication management system. *Journal of Clinical Nursing, 22*(3-4), 579-589.

Rosenberg, A., Chase, G., Omar, R., Taylor, J., & von Rosing, M. (2011). *Applying Real-World BPM in a SAP Environment.* Boston: Galileo Press.

Rostami, P., Power, M., Harrison, A., Bramfitt, K., Williams, S. D., Jani, Y., . . . Tully, M. P. (2017). Learning from the design, development and implementation of the Medication Safety Thermometer. *International Journal for Quality in Health Care, 29*(2), 301-309.

Saaty, T. L. (1980). *The Analytical Hierarchy Process.* New York: McGraw Hill.

Saaty, T., & Kulakowski, K. (2016). *Axioms of the Analytical Hierarchy Process (AHP) and its Generalization to Dependence and Feedback: the Analytic Network Process.* Retrieved January 2019, from www.researchgate.net: https://www.researchgate.net/publication/303368146_Axioms_of_the_Analytic_Hierarchy_Process_AHP_and_its_Generalization_to_Dependence_and_Feedback_The_Analytic_Network_Process_ANP

Sadiq, S., Governatori, G., & Naimiri, K. (2007). Modeling control objectives for business process compliance. *Proceedings from 5th International Conference on Business Process Management* (pp. 149-164). Berlin, Heidleberg: Springer.

Siriam, R. (2012). A soft and hard systems approach to business process management. *Systems Research and Behavioral Science, 29*, 87-100.

Smart, P. A., Maddern, H., & Maull, R. S. (2009). Understanding business process management: implications for theory and practice. *British Journal of Management, 20*(4), 491-507.

Suchman, A. L. (2011). Organizations as miachines, organizations as conversations: two core methaphors and their consequnces. *Medical Care, 49*(12), 43-48. doi:10.1097/MLR0b13e3181d55a5

Supply Chain Council Inc. (2012). *Supply Chain Operations Reference Model Revision 11.0.* Retrieved November 2017, from www.supply-chain.org.

Swenson, K. D., & von Rosing, M. (2015). What is Business Process Management? In M. von Rosing, A. W. Scheer, & H. von Scheel, *The Complete Business Process Handbook* (pp. 79-88). Amsterdam: Elsevier.

Thomas, E. J., Studdert, D. M., Burstin, H. R., Orav, E. J., Zenna, T., Williams, E. J., . . . Brennan, T. A. (2000). Incidence and ypes of adverse events and negligent care in Utah and Colorado. *Medical Care, 324*(6), 261-271.

Trkman, P. (2010). The crticial success factors of business process management. *International Journal of Informaiton Management, 30*(2), 125-134.

Trkman, P. (2013). Increasing process orientation with business process management critical practices. *International Journal of Information Management, 33*(1), 48-60.

Uberoi, R. S., & Sibal, A. (2008). Process Model for Improved Medication Management. *Apollo Medicine, 5*(4), 393-398.

United Nations. (2018). *Academic Impact Capacity-building.* Retrieved January 2018, from www.academicimpact.un.org: https://academicimpact.un.org/contentcapacity-building

Urquhart, B. S., Mitton, C., & Peacock, S. (2008). Introducing priority setting and resource allocation in home and community care programs. *Journal of Health Services Research and Policy, 13*(1), 41-45.

Van der Aalst, W. M., Hofstede, A. H., & Weske, M. (2003). Business Process Management A Survey. In W. Van der Aalst, & M. Weske, *Business Process Management BPM 2003 Lecture Notes in computer Science Volume 2678.* Berlin, Heidelberg: Springer.

Varallo, F. R., Guimaraes, S. D., Abjaude, S. A., & Mastroianni, P. D. (2014). Causes for the underreporting of adverse drug events by health professionals: a systematic review. *Revista da Escolade Enfermagen da USP, 48*(4), 739-747.

Vera, A., & Kuntz, L. (2007). Process-based organization design and hospital efficiency. *Health Care Management Review, 32*(1), 55-65.

Verrue, C., Pterovic, M., Mehuys, E., Boussery, D., Somers, D., Spinewine, A., . . . Vander Stichele, R. (2011). Organization of the medication management process in Belgian nursing homes. *Journal of the American medical Directors Association, 12*(4), 308-311.

Vincent, C., Neale, G., & Woloshynowych, M. (2001). Adverse events in British hospitals: preliminary retrospective record review. *British Medical Journal, 322*(7285), 517-519.

von Rosing, M., & Laurier, W. (2015). An introduction to the business ontology. *International Journal of Conceptual Structures and Smart Applications, 3*(1), 20-41.

von Rosing, M., & von Scheel, H. (2016). Using the Business Ontology to develop Enterprise Standards. *Journal of Conceptual Structures and Smart Applications, 4*(1), 48-70. doi:10.4018/IJCSSA.2016010103

von Rosing, M., & Zachman, J. A. (2017). The Need for a Role Ontology. *International Journal of Conceptual Structure and Smart Applications, 5*(1), 1-24.

von Rosing, M., Laurier, W., & Polovina, S. (2014). The BPM Ontology. In M. von Rosing, M. Scheer, & H. Scheel, *The Complete Business Process Handbook, Body of Knowledge from Process Modeling to BPM Volume 1* (pp. 102-107). USA: Morgan Kaufmann Publishers Inc.

von Rosing, M., Scheer, A. W., & von Scheel, H. (2014). *The Complete Business Process Handbook Body of Knowledge from Process Modeling to BPM* (Vol. 1). USA: Morgan Kaufmann.

von Rosing, M., Urquhart, B., & Zachman, J. (2015). Using a business ontology for structuring artefacts: Example Northern Health. *International Journal of Conceptual Structures and Smart Applicaitons, 3*(1), 42-85.

Wilson, R. M., Runciman, W. B., Gibberd, R. W., Harrison, B. T., Newby, L., & Hamilton, J. D. (1995). The quality in Australian health care study. *Medical Journal of Australia, 163*(9), 458-476.

Winter, R., & Fischer, R. (2006). Essential layers, artifacts and dependencies. *Enterprise Distributed Object Computing Conference Workshops EDOCW'06* (pp. 1-30). IEEE International. doi:https://ieeexplore.ieee.org/abstract/document/4031290

Wouters, R. (2015). Engineering performant, innovative and sustainable health systems. *International Journal of Integrated Care, 15*(Supplement 5).

Xiang, J., Archer, N., & Detlor, B. (2014). Business process redesign project success the role of socio-technical theory. *Business Process Management Journal*, 773-792.

Appendices

Appendix 1. Listing of Ontologies

Ontology Name	Brief Description	References
Business Ontology	The Business Ontology is a foundational ontology applicable to various domains. It defines basic notions like objects, relations, structure, arrangements and so on. It provides a meta model of a conceptual schema with a system of meta-level categories. Providing real-word enterprise semantics for general enterprise modelling languages. It was designed in collaboration between academics and industry practitioners	von Rosing, M., & Laurier, W., (2015), An Introduction to the Business Ontology, *International Journal of Conceptual Structure and Smart Applications,* 3, : 20-41 von Rosing, Zachman, J. (2017). The Need for a Role Ontology. International Journal of Conceptual Structures and Smart Applications. Volume 5, Issue 1
BPM Ontology	The BPM Ontology is a domain ontology based on the business ontology by specializing the terms to process concepts introduced in the core-reference ontology. As a domain ontology, the BPM Ontology could be linked to a specific application or task.	von Rosing, M., Scheer, A. W., von Scheel, H., (2015) The Business Process Management Handbook. Boston: Morgan Kaufmann. doi:10.1016/ B978-0-12-799959-3.00007-0
FIBO – Financial Industry Business ontology	Described as a business conceptual ontology that provides a shared language for those involved in the financial industry. It was developed through collaboration of vendors and members of the financial industry.	http://www.edmcouncil.org/financialbusiness
REA – Resource Event Actor Business Ontology	Based on a conceptual accounting framework and used in development of accounting systems. The	O'Leary, D.E. (2010) Enterprise ontologies: Review and an activity theory approach,

	original REA ontology included core economic phenomena of exchanges, resource-agent dependencies, resource dependencies, agent dependencies and commitments. REA continues to be developed and has become embedded in some software standards.	*International Journal of Accounting Information Systems, 11:* 336-352 Geerts, G.L. (2000) The Ontological Foundation of REA Enterprise Information Systems retrieved March 28 from https://www.researchgate.net/profile/Cheryl_Dunn/publication/228583572_The_ontological_foundation_of_REA_enterprise_information_systems/links/542583920cf238c6ea7411b7.pdf
SBMO Strategic Business Model Ontology	The focus of the ontology is on the goals of the business which is in contrast to the other business model ontologies that focus more on the value creation and participants within business	Samavi, R., Yu, E. and Topaloglou, T. (2009) Strategic Reasoning about business models: a conceptual modeling approach, *Information Systems and e-Business Management,* 7:171-198
TOVE – Toronto Virtual Enterprise	This is a formal ontology with the capability of describing enterprise in general. It is made up of a set of 13 sub ontologies as follows: Activity, Time, Cost, Resource Inventory, Quality, transportation, Manufacturing Resource, Order, Organizational, Manufacturing	Osterwalder, A., (2004) *The Business Model Ontology A Proposition in a Design Science Approach* retrieved March 25 from http://www.uniempre.org.br/user-files/files/TheBusiness-Model-Ontology.pdf O'Leary, D.E. (2010) Enterprise ontologies: Review and an activity theory approach, *International Journal of Accounting Information Systems*, 11:336-352
TEO - The Edinburgh Enterprise Ontology	The Edinburgh group has developed an ontology that can be used to describe enterprises generally and can also be used	Osterwalder, A., (2004) *The Business Model Ontology A Proposition in a Design Science*

	to specify software system requirements. This ontology has been described as being less formal then TOVE.	*Approach* retrieved March 25 from http://www.uniempre.org.br/user-files/files/TheBusiness-Model-Ontology.pdf O'Leary, D.E. (2010) Enterprise ontologies: Review and an activity theory approach, *International Journal of Accounting Information Systems*, 11:336-352
BFO – Basic Formal Ontology	BFO is an upper level ontology widely used in the healthcare domain. It consists of many sub ontologies which are divided into two categories: continuant and occurrent. Continuant (snapshot or point in time) or occurrent (process which occurs over time).	Blobel, B., Goossen, W., & Brochhausen, M., (2014), Clinical modeling-A critical analysis, *International Journal of Medical Informatics* 83: 57-69
e3Value	Focus is e-commerce and is based on Value creation. It supports a high level perspective and includes Actor, Value Object, Value Transfer, Value Port and Value Interface. These core building blocks are then used to represent value chains.	Pombinho, J., Aveiro, D., & Tribolet, J. (2014) A Matching Ontology for e3Value and DEMO A sound bridging of Business Modelling and Enterprise Engineering
Business Model Ontology	Business Model Ontology that is built on nine building blocks within four areas. The four areas are: Product, Customer Interface, Infrastructure Management and Financial Aspects, The nine building blocks are: Value Proposition, Target Customer, Distribution Channel, Relationship, Value Configuration, Capability, Partnership, Cost Structure and Revenue Model	Osterwalder, A., (2004) *The Business Model Ontology A Proposition in a Design Science Approach* retrieved March 25 from http://www.uniempre.org.br/user-files/files/TheBusiness-Model-Ontology.pdf
HL7 – Health Language 7	Service oriented architecture healthcare ontology which	(HL7) Health Level Seven International (2015) *About*

	focuses on electronic information exchange. Health Level Seven International is a standard setting organization that focuses on setting standards that enable exchange, integration, sharing and retrieval of electronic health information	*HL7,* accessed January 2016 from http://www.hl7.org/about/index.cfm?ref=nav
ARIS – Architecture of Integrated Information Systems	Enterprise ontology consisting of 12 classes Function, Organizational Unit Human output, goal, event, application software, output, input, environmental data, event, hardware, and machine	Scheer, AW, (1998b) *Business Process Engineering,* Berlin Springer Verlag, as cited by O'Leary, D.E. (2010) Enterprise ontologies: Review and an activity theory approach, *International Journal of Accounting Information Systems, 11:* 336-352
SAP – Shape Acquisition and Processing	Commercial based and provides an extensive vocabulary to be used in the SAP enterprise software. It has been compared to REA.	O'Leary, D.E. (2010) Enterprise ontologies: Review and an activity theory approach, *International Journal of Accounting Information Systems,* 11:336-352

Table 16 Listing of Ontologies

Appendix 2. Interview Guide for NH Leaders

Interview guide: Post development of Business Architecture Artefacts:

1. Have you been involved in the development of any of the following artefacts:
    a. Strategy Map,
    b. Business Model
        i. Value Chain
        ii. Accountability Model
        iii. Operating Model
        iv. Performance Model
2. Was the artefact developed for an organizational business area or for an end-to-end process within the organization?
    a. Which area or process?
3. How confident are you that each of the artefacts is complete and appropriately represents the organizational business area or end-to-end process for which it was created?
4. What benefits, if any, do you think these artefacts have for the organization?
5. Are the artefacts helpful in increasing your understanding of how the overall organization is structured?
6. Do the artefacts provide insight into where improvement efforts should be directed?
7. Does the Performance Model assist you in understanding or communicating with others how the day to day processes are contributing to the realization of the organizations strategy?
8. What did you find useful about your participation in this activity?
9. Do you have any suggestions on how the process could have been improved?
10. What would you suggest as next steps in the communication or use of business architecture artefacts within the organization?
11. Are there any additional comments you would like to make in respect to the development or use of Business Architecture within Northern Health?

Appendix 3. Interview Guide for Study Participants

Interview guide: Post development of the medication management process model:

1. Have you been involved in the development of the end-to-end process model for medication management? What role did you play?
2. Are you aware of the performance measures being reported within the organization in respect to medication management? How confident are you that the current performance measures being reported for medication management are appropriate? Why?
3. How confident are you that the medication management practices in your facility minimize the risk of medication errors? What changes do you think would further reduce the risk of medication errors?
4. Do you think documented processes would be helpful in reducing errors related to medication management? How?
5. How important is it for process to be both effective (achieve what it was intended to achieve) and efficient (deliver quality at lowest cost)?
6. What are your thoughts on the efficiency of the medication management process in your facility?
7. Do you have any suggestions on how the process could be made more efficient?
8. The medication management process spans several organizational departments. What challenges do you perceive exist in developing an end-to-end process model for processes such as medication management that span multiple departments?
9. How important do you perceive the need for standard processes to be in respect to the medication management process?
10. Are there any additional comments you would like to make in respect to the development or use of the end-to-end process model for medication management?

Appendix 4. Workshop Participant Information Letter and Consent Form

Date _____

Incorporating Business Process Management and Business Ontology to Improve Medication Management Safety and Quality

Project Lead: Bonnie Urquhart
University of Northern British Columbia
Prince George, BC V2N 4Z9
e-mail Urquha2@unbc.ca and/or (250) 565-2493 -

I am conducting a research study that will explore how Business Process Management and Business Ontology can be incorporated into an approach to improve medication management safety and quality. This research study is undertaken in partial fulfillment of the requirements of my Doctorate of Philosophy (PhD) in Health Sciences from the College of Arts, Social and Health Sciences at the University of Northern British Columbia. The application for research regarding this study has been reviewed by the Research Ethics Board of both UNBC and Northern Health.

I will be carrying a dual role during the study, one as the researcher and the other as Regional Director of Planning and Performance Improvement. My role in respect to this study will be to facilitate information sharing related to Business Process Management and Business Ontology with staff and physicians as well as collect participants perspectives on the barriers and benefits of this approach to support quality and process improvement. All necessary steps will be taken to manage any potential conflict of interest arising from my dual role as researcher and Regional Director, Planning and Performance Improvement

Purpose of Project

Northern Health has committed to improve medication management safety and quality. An oversight governance committee, Medication Safety and Quality Committee (MSQC), has been formed under the leadership of Dr. Dana Cole, Regional Director Pharmacy Services. Members of the MSQC as well as members of the working groups reporting to that Committee will be invited to participate in this study along with staff that engaged in one or more of the quality improvement projects endorsed by the Committee during the period of this study.

Two workshops are planned as part of the study. Workshop invitees will include members of the MSQC as well as subject matter experts leading working groups reporting to the MSQC.

What will happen during the study?

Your participation will consist of attendance at one or two of 3 to 4 hour workshops to be held at a Northern Health site.

- The first workshop will be used to review and validate business artefacts related to medication management in Northern Health. The business artefacts to be validated include business competency models, strategy maps, performance models, operating models and an end-to-end process model for medication management. The first workshop will also include orientation and introduction to Business Process Management, business ontology and the business artefacts currently in use in Northern Health.
- The second workshop will be used to identify, prioritize, select, sequence and assign quality and process improvement projects related to medication management safety and quality.

You are not obligated in any way to participate in this study. Your participation in the research is strictly voluntary. Participation will consist of your participation in one or more workshops where medication management relevant business artefacts will be developed and specific processes for improvement will be identified. Given the nature of workshops and group participation confidentiality of the opinions and information you share during the workshop(s) cannot be assured. At no time will any specific comments be attributed to an individual in any report out of this study without prior consent of that individual. The study report will include the business artefacts derived from the workshop and will also include a record of the process used to rank the medication management processes selected for improvement projects.

In addition to these two workshops two sets of interviews will be conducted as part of this study.

- The first group of interviewees will be individuals who have participated in a quality improvement project during the duration of this study.
- The second group will be senior leaders within Northern Health who have had an opportunity to develop or review business artefacts using the Layered Enterprise Architecture Design standards for business architecture.

These interviews are currently planned to be held in May to June of 2017. A separate information letter and consent form will be provided should you fit the selection criteria for either of the interview groups.

Risks or benefits to participating in the project

I do not anticipate that there will be any personal benefit or risk to participants in this study. The interviews will be conducted during your regular worked hours and the interview time will be included in your regular compensation.

Physician time will be compensated based on Northern Health practices related to physician time spent on quality improvement initiatives.

I anticipate that results from this study will benefit Northern Health and the academic community at large by providing insight into the barriers, benefits and challenges of using Business Process Management and Business Ontology in addressing safety and quality in the healthcare system overall and more specifically in the area of safe and high quality medication management services.

Study Results

I will be submitting a final report on the study to UNBC as well as sharing the result of the study within Northern Health. I may also pursue academic publication of portions of the study in relevant academic journals or present results at academic or health related conferences.

Questions or Concerns about the project

If you have any questions regarding this study or your participation please contact the Project Lead at the email address or phone number at the top of this document.

If you have any concerns or complaints about your rights as a research participant and/or your experiences while participating in this study, contact the UNBC Office of Research at 250-960-6735 or by e-mail at reb@unbc.ca.

Participant Consent and Withdrawal – Workshop Participants

CONSENT

I have read or been described the information presented in the information letter about the project:

YES NO

I have had the opportunity to ask questions about my involvement in this project and to receive additional details I requested.

YES NO

I understand that if I agree to participate in this project, I may withdraw from the project at any time up until the report completion, with no consequences of any kind. I have been given a copy of this form.

YES NO

I agree to be recorded (*if applicable*).

YES NO

I agree that my name can be used (*if applicable*).

YES NO

Follow-up information can be sent to me at the following e-mail address:

Email: _____

YES NO

Signature (**or note of verbal consent**): _____

Name of Participant (Printed): _____

Date: _____

Appendix 5. Interview Information Letter & Consent Form

Information Letter / Consent Form for Interviewees

Date _____

Incorporating Business Process Management and Business Ontology to Improve Medication Management Safety and Quality

Project Lead: Bonnie Urquhart
University of Northern British Columbia
Prince George, BC V2N 4Z9
e-mail Urquha2@unbc.ca and/or (250)613-5581 -

I am conducting a research study that will explore how Business Process Management and Business Ontology can be incorporated into an approach to improve medication management safety and quality. This research study is undertaken in partial fulfillment of the requirements of my Doctorate of Philosophy (PhD) in Health Sciences from the College of Arts, Social and Health Sciences at the University of Northern British Columbia. The application for research regarding this study has been reviewed by the Research Ethics Board of UNBC and Northern Health.

Purpose of Project

Managers and healthcare practitioners are responsible to provide safe, effective and efficient service to their patients. Services such as medication management span numerous providers and organizational groups. It is proposed that having a shared understanding of end-to-end process and being able to connect the individual processes to the larger system of services could facilitate quality improvement and identification of technical efficiencies within a healthcare organization.

This study will specifically focus on the end-to-end process of medication management in Acute Care and Long Term Care facilities. The study will explore the benefits & challenges of using Business Ontology and Business Process Management in a multi-site geographically dispersed healthcare organization.

Northern Health has committed to improve medication management safety and quality. An oversight governance committee, Medication Safety and Quality Committee (MSQC), has been formed under the leadership of Dr. Dana Cole, Regional Director Pharmacy Service. Members of the MSQC as well as members of the working groups reporting to that Committee will be invited to participate in this

study along with staff that engaged in one or more of the quality improvement projects endorsed by the Committee during the period of this study. I have been invited to sit in on MSQC meetings as a non-voting member.

Your Participation

You are being invited to participate in this project because you have participated in a quality improvement project in medication management or you are one of the senior leaders within Northern Health who have had an opportunity to develop or review business artefacts using the Layered Enterprise Architecture Design standards for business architecture.

What will happen during the project?

Participation will consist of one audio taped interview with the principal investigator (Bonnie Urquhart). It is anticipated that the interview will take between 30 and 60 minutes of your time. The interview will be conducted during your regular scheduled worked hours. The audio tapes will be transcribed by me as the researcher or by a transcriptionist who has signed a confidentiality agreement. Any expense in hiring of a transcriptionist will be paid by me as the principal researcher. The transcribed information will be analyzed to identify barriers and benefits of incorporating Business Process Management and Business Ontology to support improvements in medication management safety and quality.

You are not obligated in any way to participate in this study. Your participation in the research is strictly voluntary. Anonymity cannot be guaranteed.

All data collected, including the audio tapes of the interviews and the transcribed data will be kept secured in a locked cabinet during the study period and destroyed upon completion of the study and acceptance of the final report by UNBC. Data collected from your interview will not be made available to anyone other than the transcriptionist or me. All comments will be treated as confidential information and any quotes used in the final report will not include identifiable data. If you participate in the study and subsequently decide to withdraw prior to the acceptance of the final report by UNBC the data collected from your interview will be removed from the report and destroyed within 30 days of your notification to me of your decision to withdraw.

Risks or benefits to participating in the project

I do not anticipate that there will be any personal benefit or risk to participants in this study. The interviews will be conducted during your regular worked hours and the interview time will be included in your regular compensation.

I anticipate that results from this study will benefit Northern Health and the academic community at large by providing insight into the barriers, benefits and challenges of

using Business Process Management and Business Ontology in addressing safety and quality in the healthcare system overall and more specifically in the area of safe and high quality medication management services.

Potential Conflict of Interest

In addition to my role as Principal Investigator on this study I hold the position of Regional Director, Planning and Performance Improvement in Northern Health. In my role as Principal Investigator I will be responsible for conducting workshops and interviews in addition to creating and reviewing documentation and business artefact related to the medication management processes within Northern Health. The content of the documents will be provided by staff and physicians within Northern Health who are directly involved in medication management processes or have participated in quality improvement projects related to medication management processes.

In my role as Regional Director, Planning and Performance Improvement I may also, as time permits, participate in medication management quality improvement projects during the study.

All necessary steps will be taken to manage any conflict of issues arising from my role as Principal Investigator and Regional Director, Planning and Performance Improvement.

Study Results

I will be submitting a final report on the study to UNBC as well as sharing the result of the study within Northern Health. I may also pursue academic publication of portions of the study in relevant academic journals or present results at academic or health related conferences.

Findings from this study will be made available to all participants. If you are interested in receiving a copy of the final report please contact me via email and I will provide you with a copy of the final report.

Questions or Concerns about the project

If you have any questions regarding this study or your participation please contact the Project Lead at the email address or phone number on the first page.

If you have any concerns or complaints about your rights as a research participant and/or your experiences while participating in this study, contact the UNBC Office of Research at 250-960-6735 or by e-mail at reb@unbc.ca.

Participant Consent and Withdrawal

Taking part in this study is entirely up to you. You have the right to refuse to participate in this study. You have the right to refuse to answer any questions that make you feel uncomfortable. If you decide to take part, you may choose to pull out of the study at any time before the acceptance of the final report by UNBC without giving a reason and without any negative impact on your employment with Northern Health.

CONSENT

I have read or been described the information presented in the information letter about the project:

YES NO

I have had the opportunity to ask questions about my involvement in this project and to receive additional details I requested.

YES NO

I understand that if I agree to participate in this project, I may withdraw from the project at any time up until the report completion, with no consequences of any kind. I have been given a copy of this form.

YES NO

I agree to be recorded (*if applicable*).

YES NO

I agree that my name can be used (*if applicable*).

YES NO

Signature (**or note of verbal consent**): _____

Name of Participant (Printed): _____

Date: _____

Appendix 6. Workshop Attendance Log

Position Title	Professional Background	Consent on file	Dec 8	Dec 15	Jan 24	Interviewed
Regional Director Pharmacy	Pharmacist	Yes	Yes	Yes	Yes	Yes
Chief Operating Officer Northern Interior	Nurse Executive	Yes	Yes	Yes	Declined	No
Director, Clinical Information Systems	IT Administration	Yes	Yes	Yes	Yes	No
Chief Medical Information Officer and Family Physician	Physician	Yes	Yes	Yes	Declined	No
Regional Medication Safety Officer	Nurse	Yes	Yes	Yes	Yes	Yes
Regional Medication Safety & Informatics Pharmacist	Pharmacist	Yes	Yes	Yes	Yes	No
Director Inpatient and Restorative Services	Nurse	Yes	Yes	Declined	Declined	No
Pharmacy Manager Northeast HSDA	Pharmacist	Yes	Yes	Yes	Declined	Yes
Administrative Assistant to Regional Director Pharmacy	Administration	Yes	Yes	Yes	Declined	No
Director of Care Fort St. John Hospital	Nurse	Yes	Yes	Declined	Declined	Yes
Chief Nursing Officer, Lead Professional	Nurse	Yes	Yes	Declined	Yes	No

Practice Strategy						
Professional Practice Leader Clinical Pharmacy Services	Pharmacist	Yes	Yes	Yes	Yes	Yes
Medication Use Management Pharmacist	Pharmacist	Yes	Yes	Declined	Yes	No
Antimicrobial Stewardship Pharmacist	Pharmacist	Yes	Yes	Yes	Yes	Yes
Health Service Administrator FSJ Hospital	Nurse	yes	Yes	Declined	Declined	Yes
Process Architect	Business	Yes	Yes	Yes	Yes	Not Asked
Process Architect	Business	Yes	Yes	Declined	Yes	Not Asked
Pharmacy Manager University Hospital of Northern BC	Pharmacist	Yes	Yes	Declined	Declined	No
Regional Manager, Risk and Compliance	Risk Management	Yes	Yes	Yes	Yes	Yes
Regional Medication Use Management Pharmacist	Pharmacist	Yes	Yes	Declined	Declined	Yes
Regional Manager Pharmacy Solutions	IT	Yes	Yes	Yes	Yes	Yes
Lead, Regional Quality Processes	Business	Yes	Yes	Yes	Yes	Yes

Table 17 Workshop Attendance Log

Appendix 7. List of Recommended Performance Measures

of physician specific order sets;
% of compliance with privacy and confidentiality audits
# of active order sets that are up to date
# of average turns of inventory
# of clinical pharmacy hours per 100 inpatient days
# of facilities meeting National Association of Pharmacy Regulatory Authorities (NAPRA) standards
# of interventions per hour clinical pharmacist time
# of IV to PO step down interventions
# of Medication Utilization Reviews Completed Annually
# of Medication Utilization Reviews Completed Annually for AMS;
# of anti-infective Drug Therapy Problems resolved per inpatient admission
# of CQI projects completed that identified and realized efficiency gains
# of identified Drug Therapy Problems per 100 inpatient admissions
# of medical students receiving clinical education during their 3rd year rotation
# of medication doses administered in error per PSLS resulting in harm level greater than or equal to level 3 harm
# of pharmacy residents in NH
# of pharmacy technician students receiving education annually
# of regional order sets;
# of resolved drug therapy problems per 100 outpatient visits
# of resolved drug therapy problems per 100 resident days
# of Resolved DTPs per 100 inpatient admissions
# of staff who have had a performance review in past 24 months
# of Patient assessments completed by pharmacists or pharmacy technician
# of site specific order sets
# of incident reports of staff exposure
% of facilities with infusion pumps meeting established standard
% of identified critical processes with process maturity level 3 or above
% of Interventions accepted in prospective audit and feedback regarding antibiotics
% of IV medications infused through MDL
% of meds delivered late per PSLS reports
% of meds dispensed in unit dose format including ward stock
% of meetings where all NH representatives attended
% of nursing units with narcotic and controlled drugs stored in AMDCs
% of alignment NH formulary to Provincial formulary
% of discrepancies (requiring intervention) found after/during medication reconciliation
% of documented processes with Standard Operating Procedures
% of facilities dispensing patient specific medications on 24 hour batch
% of formulary reviews completed by NH
% of individuals expected to complete SMOW education who have taken SMOW
% of internal shipping errors

% of medication errors while AMDC on override
% of medication orders entered accurately as assessed by pharmacist at verification
% of medications accessed through AMDC on over-ride
% of nurses who have completed SMOW education module
% of oral to IV of high bioequivalent
% of orders clarified by Pharmacist (not therapeutic interchange)
% of patients educated on Medications by a pharmacist
% of patients with medication therapy plan documented as part of "care plan" (longitudinal plan)
% of pharmacists who have completed SMOW education module
% of pharmacy technicians who have completed SMOW education module
% of physicians who have completed SMOW education module
% of staff/physicians accessing education opportunities
% of unit clerks who have completed SMOW education module
% of VTE audits where patients received appropriate prophylaxis
% of oral solid meds with bar code on unit dose packaging;
% of patients with Medication Reconciliation Completed within 24 hours of admission
% of Patients with Medication Reconciliation Completed at Discharge
% of patients with medication therapy plan documented as part of "plan of care" (episodic plan)
% of products with appropriate Beyond Use Dating according to NAPRA standards
Actual inventory value or estimate based on Value on Hand reported in Cerner for all NH Pharmacies
Average Length of Stay per acute inpatient admission
Average Turnaround time of medications from order scan to release of medication (Pyxis)
Cost of antimicrobials per 100 inpatient days
Cost of expired drugs as % of inventory cost
Cost of expired drugs as percentage of drug budget
Cost of expired drugs for credit
Cost of expired drugs not for Credit as a % of inventory
Cost of expired drugs not for credit as a % of total expired drugs
Cost of expired drugs not for credit in pharmacy inventory
Cost of IV antibiotics per 100 inpatient days
Cost of oral antibiotics per 100 inpatient days
Defined Daily Dose (DDD) per 100 patient days for targeted antibiotic
Door to needle time for thrombolytic
Drug Cost per 100 inpatient days
Drug cost per 100 resident days in LTC facilities (non Plan B)
Drug Costs per inpatient day
High cost antineoplastic drug utilization in pharmacy
Order entry average time per pharmacy department (% variance from benchmark)
Rate of discrepancies from best practice identified during pharmacy audit of narcotics books
Reported patient satisfaction on medication education provided
Reported patient satisfaction with pain management during hospital stay
Student Satisfaction Survey

Time of antibiotic administration from ordering
Total Cost of Expired Drugs
Turnaround time of internal medication inventory transfers based on established benchmark standards.
Work life Survey - level of satisfaction
% of orders compliant with Safe Medication Order Writing (SMOW)
# of pharmacist clinical training weeks provided
% of pharmacists who meet competency measures for clinical pharmacy
% of reported errors per orders entered as per PSLS reports
Order verification average time per pharmacy department (% variance from benchmark)

Table 18 Complete List of Suggested Measures

Appendix 8. Meta Model of Understanding

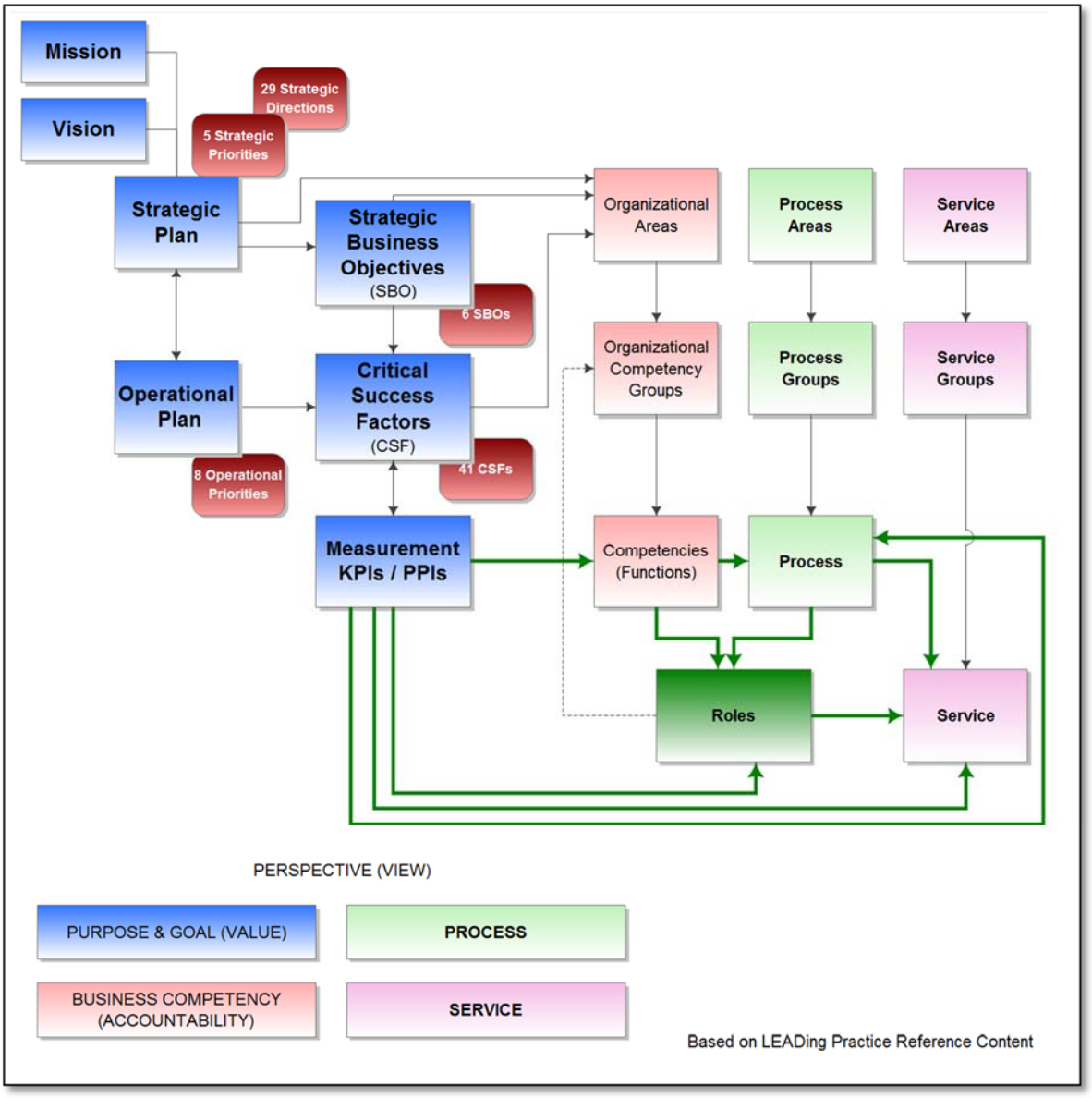


Figure 11. Meta Model of Understanding

Appendix 9. Strategy Map

Medication Management Strategy Map

Organization Strategic Business Objective

- Medication Management Strategic Business Objective
  - Medication Management Critical Success Factor
    - Medication Management Key Performance Indicator

Improve Clinical Outcomes

- 1.0 Improve Clinical Outcomes
  - 1.1 Ensure medication reconciliation at all transitions in care
    - % of discrepancies (requiring intervention) found after/during medication reconciliation
    - % of patient with Medication Reconciliation completed within 24 hours of admission
    - % of Patients with Medication Reconciliation Completed at Discharge
  - 1.2 Improve communication of medication care plan and plan of care at all transitions
    - % of patients with medication therapy plan documented as part of "plan of care" (episodic plan)
    - % of patients with medication therapy plan documented as part of "care plan" (longitudinal plan)
  - 1.3 Ensure Optimal Medication is Prescribed
    - # of resolved Drug Therapy Problems per 100 inpatient admissions
    - # of resolved drug therapy problems per 100 resident days
    - # of resolved drug therapy problems per 100 outpatient visits (need numerator to exclude diagnostic outpatient visit)
    - % of orders clarified by Pharmacist (not therapeutic interchange)
    - Average Length of Stay per acute inpatient admission
    - # of clinical Rx hours per 100 inpatient days
    - # of active order sets that are up to date
  - 1.4 Ensure medications accurately and appropriately dispensed
    - Average turnaround time of medications from order scan to release of medication (Pyxis)
    - % of medications dispensed in unit dose format including ward stock
    - % of medication orders entered accurately as assessed by pharmacist at verification
    - % of facilities dispensing patient specific medications on 24 hour batch
    - % of reporter errors per order entered as per PSLS reports
    - Order entry average time per pharmacy department (% variance from benchmark)
  - 1.5 Ensure medications are accurately and appropriately administered
    - # of medication doses administered in error per PSLS per 100 patient days
    - % of medications infused through MDL
    - % of medications accessed through AMDC on over-ride
    - % of medication errors while AMDC on override
  - 1.6 Improve Antimicrobial Stewardship

# of IV to PO step-down interventions
# of anti-infective Drug Therapy Problems resolved per inpatient admission
% of oral to IV of high bioequivalent drugs
% of Interventions accepted in prospective audit and feedback regarding antibiotics
Defined Daily Dose (DDD) per 100 patient days for targeted antibiotic
DDD of IV vs PO formulations of high bioequivalence antimicrobials
# of Medication Utilization Reviews Completed Annually for AMS;

1.7 Optimize Medication Education and Self-Management

% of patients educated by a pharmacist on Medications
Reported patient satisfaction on medication education provided

Improve patient and family experience

2.0 Improve patient and family experience

2.1 Ensure informed shared decision making regarding medication therapy
2.2 Ensure appropriate information is shared regarding timelines and access

Improve Provider Engagement

3.0 Improve Staff, Physician and Clinical Student Experience

3.1 Ensure they have the tools they need to do the job

Work Life survey - level of satisfaction

3.2 Provide appropriate development opportunities

% of staff/physicians accessing education opportunities

3.3 Improve and share information on performance both personal and medication safety

# of staff who have had a performance review in past 24 months

3.4 Appropriately match resources to need

# of clinical pharmacy hours per 100 inpatient days

3.5 Provide meaningful clinical education experience

# of medical students receiving clinical education during their 3rd year rotation
# of pharmacy technician students receiving education annually
# of clinicians receiving education on clinical pharmacy at orientation
Student Satisfaction Survey Scores

Control per capita cost

4.0 Control per patient cost

4.1 Increase standardization to reduce arbitrary variation

% of documented processes with Standard Operating Procedures

4.2 Increase focus on CQI to Improve efficiency through reducing non-value added activity

# of CQI projects completed that identified and realized efficiency gains

4.3 Minimize inventory cost

Cost of expired drugs in pharmacy inventory
Actual inventory value for all NH Pharmacies
# of average turns of inventory

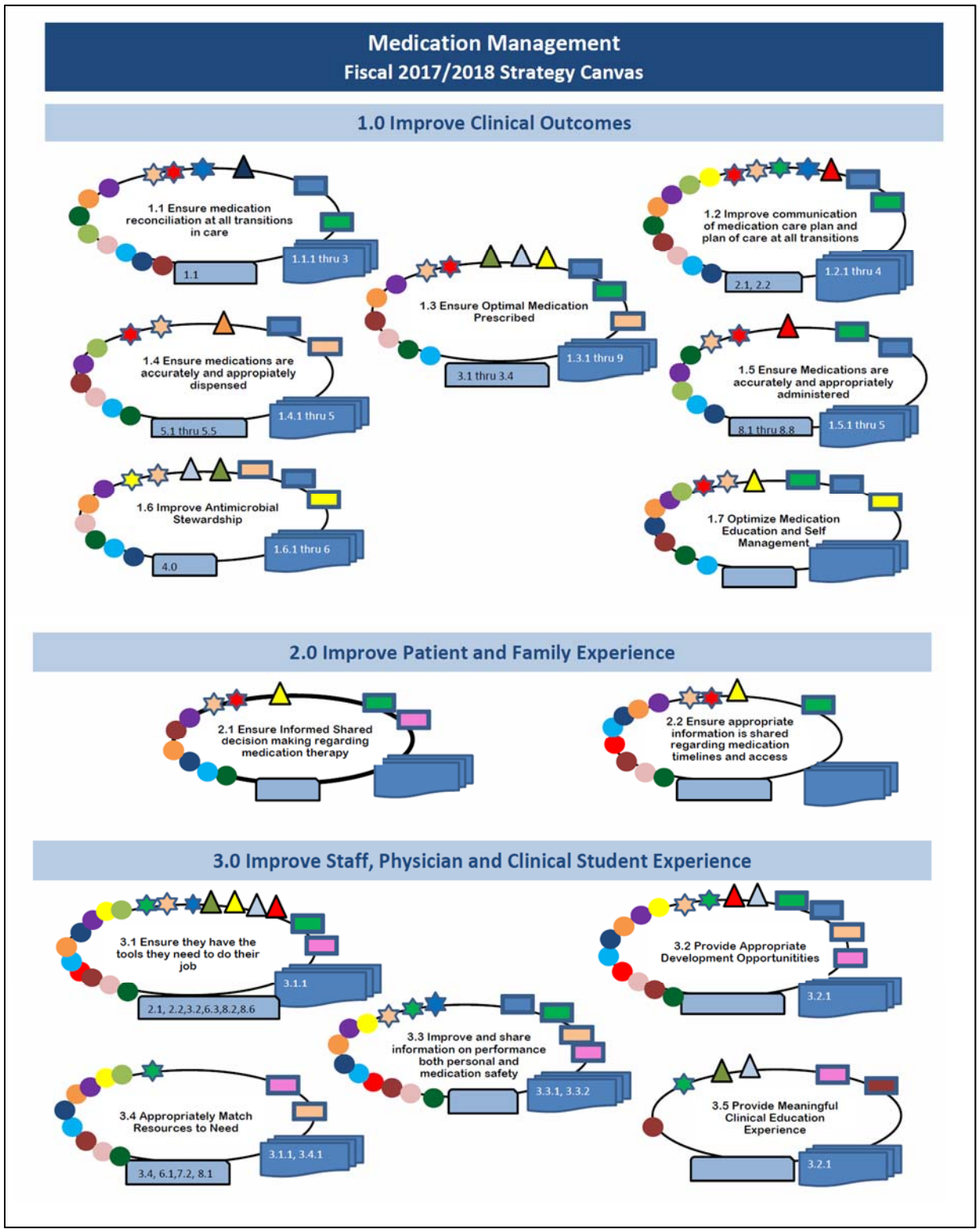
4.4 Ensure lowest cost/most effective drug therapy management

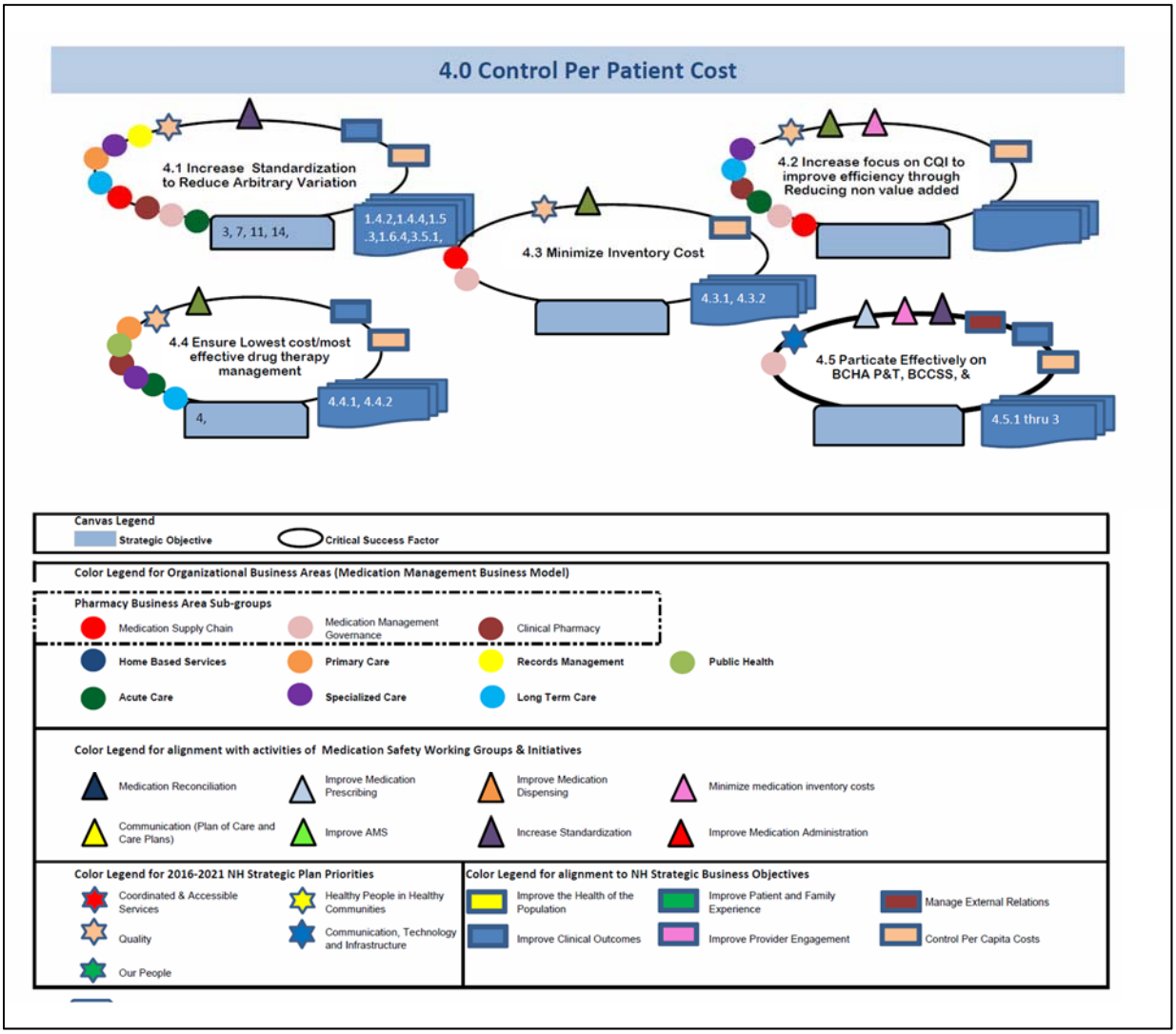
Drug cost per 100 resident days in LT facilities (non Plan B)

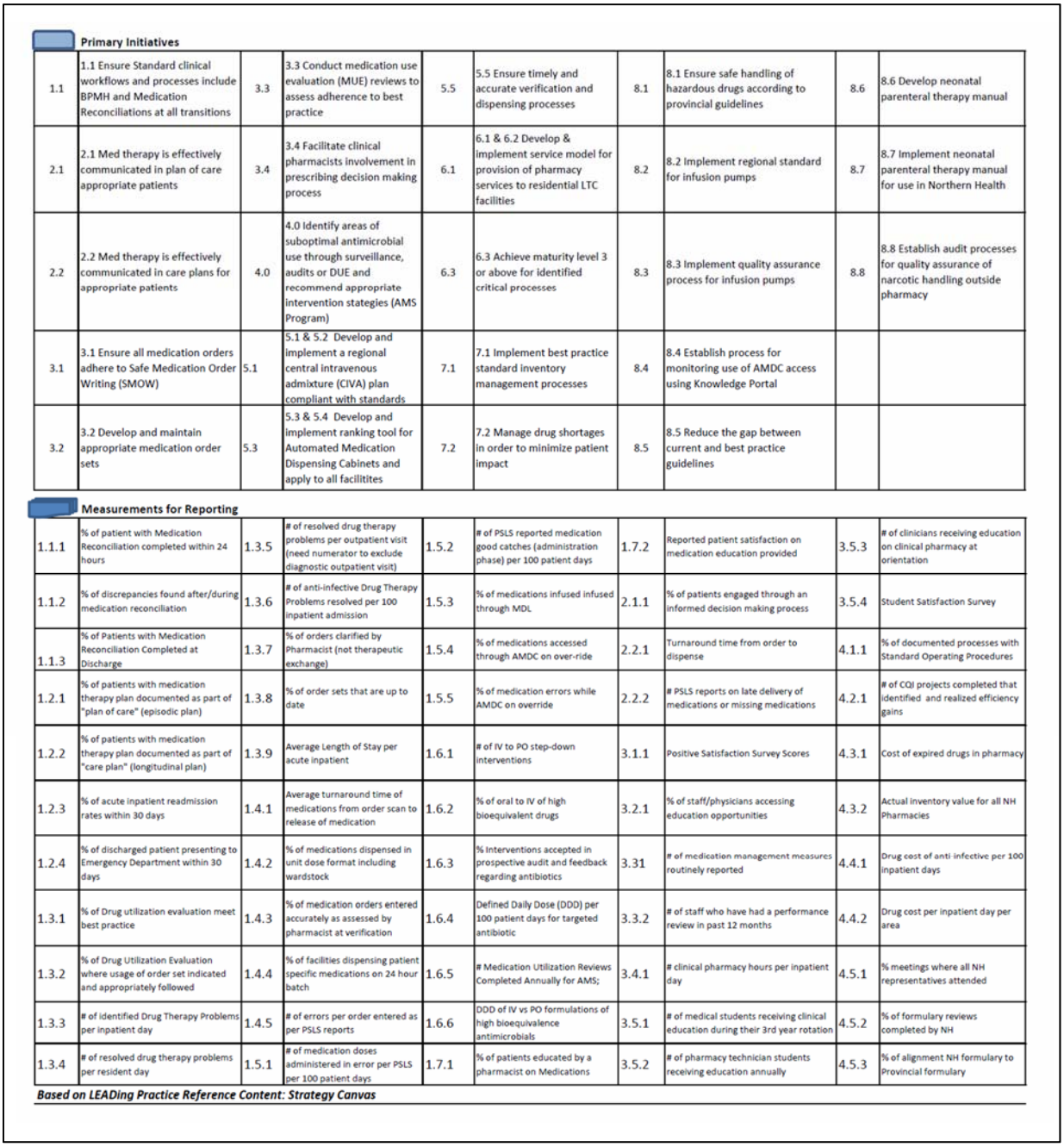
Drug cost per inpatient day
4.5 Participate effectively on BCHA P&T, BCSS & HealthPro collaborations
% of meetings where all NH representatives attended
% of formulary reviews completed by NH
% of alignment NH formulary to Provincial formulary

Table 19 Strategy Map Objects

Appendix 10. Strategy Canvas




4.0 Control Per Patient Cost
4.1 Increase Standardization to Reduce Arbitrary Variation
3, 7, 11, 14,
1.4.2,1.4.4,1.5 .3,1.6.4,3.5.1,
4.2 Increase focus on CQI to improve efficiency through Reducing non value added
4.3 Minimize Inventory Cost
4.3.1, 4.3.2
4.4 Ensure Lowest cost/most effective drug therapy management
4,
4.4.1, 4.4.2
4.5 Particate Effectively on BCHA P&T, BCCSS, &
4.5.1 thru 3
Canvas Legend
Strategic Objective
Critical Success Factor
Color Legend for Organizational Business Areas (Medication Management Business Model)
Pharmacy Business Area Sub-groups
Medication Supply Chain
Medication Management Governance
Clinical Pharmacy
Home Based Services
Primary Care
Records Management
Public Health
Acute Care
Specialized Care
Long Term Care
Color Legend for alignment with activities of Medication Safety Working Groups & Initiatives
Medication Reconciliation
Improve Medication Prescribing
Improve Medication Dispensing
Minimize medication inventory costs
Communication (Plan of Care and Care Plans)
Improve AMS
Increase Standardization
Improve Medication Administration
Color Legend for 2016-2021 NH Strategic Plan Priorities
Coordinated & Accessible Services
Healthy People in Healthy Communities
Quality
Communication, Technology and Infrastructure
Our People
Color Legend for alignment to NH Strategic Business Objectives
Improve the Health of the Population
Improve Patient and Family Experience
Manage External Relations
Improve Clinical Outcomes
Improve Provider Engagement
Control Per Capita Costs



Primary Initiatives

1.1	1.1 Ensure Standard clinical workflows and processes include BPMH and Medication Reconciliations at all transitions	3.3	3.3 Conduct medication use evaluation (MUE) reviews to assess adherence to best practice	5.5	5.5 Ensure timely and accurate verification and dispensing processes	8.1	8.1 Ensure safe handling of hazardous drugs according to provincial guidelines	8.6	8.6 Develop neonatal parenteral therapy manual
2.1	2.1 Med therapy is effectively communicated in plan of care appropriate patients	3.4	3.4 Facilitate clinical pharmacists involvement in prescribing decision making process	6.1	6.1 & 6.2 Develop & implement service model for provision of pharmacy services to residential LTC facilities	8.2	8.2 Implement regional standard for infusion pumps	8.7	8.7 Implement neonatal parenteral therapy manual for use in Northern Health
2.2	2.2 Med therapy is effectively communicated in care plans for appropriate patients	4.0	4.0 Identify areas of suboptimal antimicrobial use through surveillance, audits or DUE and recommend appropriate intervention stategies (AMS Program)	6.3	6.3 Achieve maturity level 3 or above for identified critical processes	8.3	8.3 Implement quality assurance process for infusion pumps	8.8	8.8 Establish audit processes for quality assurance of narcotic handling outside pharmacy
3.1	3.1 Ensure all medication orders adhere to Safe Medication Order Writing (SMOW)	5.1	5.1 & 5.2 Develop and implement a regional central intravenous admixture (CIVA) plan compliant with standards	7.1	7.1 Implement best practice standard inventory management processes	8.4	8.4 Establish process for monitoring use of AMDC access using Knowledge Portal		
3.2	3.2 Develop and maintain appropriate medication order sets	5.3	5.3 & 5.4 Develop and implement ranking tool for Automated Medication Dispensing Cabinets and apply to all facilitites	7.2	7.2 Manage drug shortages in order to minimize patient impact	8.5	8.5 Reduce the gap between current and best practice guidelines		

Measurements for Reporting

1.1.1	% of patient with Medication Reconciliation completed within 24 hours	1.3.5	# of resolved drug therapy problems per outpatient visit (need numerator to exclude diagnostic outpatient visit)	1.5.2	# of PSLS reported medication good catches (administration phase) per 100 patient days	1.7.2	Reported patient satisfaction on medication education provided	3.5.3	# of clinicians receiving education on clinical pharmacy at orientation
1.1.2	% of discrepancies found after/during medication reconciliation	1.3.6	# of anti-infective Drug Therapy Problems resolved per 100 inpatient admission	1.5.3	% of medications infused infused through MDL	2.1.1	% of patients engaged through an informed decision making process	3.5.4	Student Satisfaction Survey
1.1.3	% of Patients with Medication Reconciliation Completed at Discharge	1.3.7	% of orders clarified by Pharmacist (not therapeutic exchange)	1.5.4	% of medications accessed through AMDC on over-ride	2.2.1	Turnaround time from order to dispense	4.1.1	% of documented processes with Standard Operating Procedures
1.2.1	% of patients with medication therapy plan documented as part of "plan of care" (episodic plan)	1.3.8	% of order sets that are up to date	1.5.5	% of medication errors while AMDC on override	2.2.2	# PSLS reports on late delivery of medications or missing medications	4.2.1	# of CQI projects completed that identified and realized efficiency gains
1.2.2	% of patients with medication therapy plan documented as part of "care plan" (longitudinal plan)	1.3.9	Average Length of Stay per acute inpatient	1.6.1	# of IV to PO step-down interventions	3.1.1	Positive Satisfaction Survey Scores	4.3.1	Cost of expired drugs in pharmacy
1.2.3	% of acute inpatient readmission rates within 30 days	1.4.1	Average turnaround time of medications from order scan to release of medication	1.6.2	% of oral to IV of high bioequivalent drugs	3.2.1	% of staff/physicians accessing education opportunities	4.3.2	Actual inventory value for all NH Pharmacies
1.2.4	% of discharged patient presenting to Emergency Department within 30 days	1.4.2	% of medications dispensed in unit dose format including wardstock	1.6.3	% Interventions accepted in prospective audit and feedback regarding antibiotics	3.31	# of medication management measures routinely reported	4.4.1	Drug cost of anti infective per 100 inpatient days
1.3.1	% of Drug utilization evaluation meet best practice	1.4.3	% of medication orders entered accurately as assessed by pharmacist at verification	1.6.4	Defined Daily Dose (DDD) per 100 patient days for targeted antibiotic	3.3.2	# of staff who have had a performance review in past 12 months	4.4.2	Drug cost per inpatient day per area
1.3.2	% of Drug Utilization Evaluation where usage of order set indicated and appropriately followed	1.4.4	% of facilities dispensing patient specific medications on 24 hour batch	1.6.5	# Medication Utilization Reviews Completed Annually for AMS;	3.4.1	# clinical pharmacy hours per inpatient day	4.5.1	% meetings where all NH representatives attended
1.3.3	# of identified Drug Therapy Problems per inpatient day	1.4.5	# of errors per order entered as per PSLS reports	1.6.6	DDD of IV vs PO formulations of high bioequivalence antimicrobials	3.5.1	# of medical students receiving clinical education during their 3rd year rotation	4.5.2	% of formulary reviews completed by NH
1.3.4	# of resolved drug therapy problems per resident day	1.5.1	# of medication doses administered in error per PSLS per 100 patient days	1.7.1	% of patients educated by a pharmacist on Medications	3.5.2	# of pharmacy technician students receiving education annually	4.5.3	% of alignment NH formulary to Provincial formulary

Based on LEADing Practice Reference Content: Strategy Canvas

Figure 12 Strategy Canvas

Appendix 11. Business Competency Map

STRATEGIC	**Pharmacy & Medication Management Planning**	
	Strategic Direction	Portfolio Management
	Strategic Plan and Goals	Key Measurements and Performance Indicators
	Resource Allocations	Pharmacy & Medication Management Strategy Development
	Pharmacy & Medication Management Governance Planning	Regional Services Planning
	Research Best Practice	
	Medication Research	
	Medication Research Strategy	Medication Research Planning
	Relationship Management	
	Pharmacy Partner Management	Community Management
	Government Relationship	Pharmacy Public-Private Partnership
	Service Delivery Planning	
	Population Level Surveillance	Standardize Process and Practice
	Formulary Management Planning	Clinical Trial Planning and Coordination
	Business Operations Planning	Quality Improvement
TACTICAL	**Pharmacy & Medication Management Risk Management**	
	Pharmacy & Medication Management Risk Analysis	Pharmacy & Medication Management Risk Control (Adverse Events)
	Pharmacy & Medication Management Risk Measures	Pharmacy & Medication Management Risk Rule & Regulations
	Pharmacy & Medication Management Risk Monitoring	Pharmacy & Medication Management Risk Compliance
	Pharmacy & Medication Management Risk Reporting	
	Equipment Management	
	Equipment Scheduling	Equipment Maintenance
	Equipment Renting/Leasing	Equipment Tracking & Asset Management
	Supplier Management	
	Supplier Collaboration	Supplier Evaluation
	Supplier Sourcing	Supplier Monitoring
	Supplier Requirement Management	Supplier Negotiation
	Pharmacy & Medication Management Governance Management	
	Pharmacy & Medication Management Access Management	Pharmacy & Medication Management Knowledge Management
	Pharmacy & Medication Management Information Management	Pharmacy & Medication Management Governance Control & Monitor
	Pharmacy & Medication Management Governance Planning	Pharmacy & Medication Management Governance Evaluation & Audit
	Pharmacy & Medication Management Governance Compliance	Pharmacy & Medication Management Continuous Improvement
	Pharmacy Clinical Practice Management	
	Integration & Practice Management	Patient Records Management
	Pharmacy Services Financial Management	
	Operational Budget Management	Forecasting
	Capital Budget Management	Long term business planning
	Pharmacy Services Contract Management	
	Contract Negotiations	Contract Liability Management
	Contract Budget Management	Contract Compliance Management
	Pharmacy Human Resources Management	
	Human Resource Staffing	Staffing Compliment Management
	Staff Performance Management	Recruitment
	Retention	Staff Development

OPERATIONAL	**Clinical Pharmacy Access Management**	
	Order Triage	Safe Medication Order Writing
	Patient ID and Registration	Order Set Development & Management
	Medication Reconciliation	Pharmaceutical Care
	Clinical Support	Medication Administration
	Discharge Planning	Drug Therapy Monitoring
	Emergency Preparedness	
	Community Emergency Response	Contract Management and emergency execution
	Inventory and Equipment Management	
	Equipment Maintenance and Cleaning	Purchasing
	Pharmaceutical Inventory Management	Shipping and Receiving
	Medication Inventory storage	Medication Mixing & Repackaging
	Controlled Substance Management	
	Dispensing and Distribution (Pharmacy)	
	Transportation	Medication Preparation
	Medication Distribution to Point of Care	Medication Documentation
	Medication Assessment	
	Education	
	Internal clinical education pharmacy staff	External clinical education
	Internal clinical education for non pharmacy staff	
	Administration	
	Fleet Vehicle Mangement	Data Quality Improvement
	Billing	Administrative Reporting
	Travel Management	Clinical Reporting
	Extract from other Business Area Business Models specific operational competencies related to Medication Management	
OPERATIONAL	**Long Term Care Medication Management**	
	Medication Inventory Management	Medication Documentation
	Medication Dispensing	Controlled Substance Management
	Medication Administration	Medication Reconciliation & Best Possible Medication History
	Drug Therapy Monitoring	Patient Assessment
	Drug Therapy Prescribing	
	Acute Care Medication Management	
	Medication Inventory Management	Medication Documentation
	Medication Dispensing	Controlled Substance Management
	Medication Administration	Medication Reconciliation & Best Possible Medication History
	Drug Therapy Monitoring	Patient Assessment
	Drug Therapy Prescribing	
	Home Support Medication Management	
	Medication Administration	Medication Documentation
	Controlled Substance Management	Medication Reconciliation & Best Possible Medication History
	Medication Inventory Management	
	Primary Care Medication & Biological Management	
	Medication & Biological Inventory Management	Medication & Biological Documentation
	Medication & Biological Dispensing	Controlled Substance Management
	Medication Administration	Medication Reconciliation & BPMH
	Community Specialized Medication Management	
	Medication Inventory Management	Medication Documentation
	Medication Dispensing	Controlled Substance Reporting
	Medication Administration	Medication Reconciliation & Best Possible Medication History
	Drug Therapy Monitoring	Patient Assessment
	Drug Therapy Prescribing	
	Public Health	
	Medication Inventory Management	Medication Documentation
	Medication Dispensing	Controlled Substance Reporting
	Medication Administration	Medication Reconciliation & Best Possible Medication History
	Drug Therapy Monitoring	Patient Assessment
	Drug Therapy Prescribing	
	Records Management	
	Client Registration	Records Reporting & Analysis
	Records Management Services	

Figure 13 Business Competency Map

Appendix 12. Business Competency Model

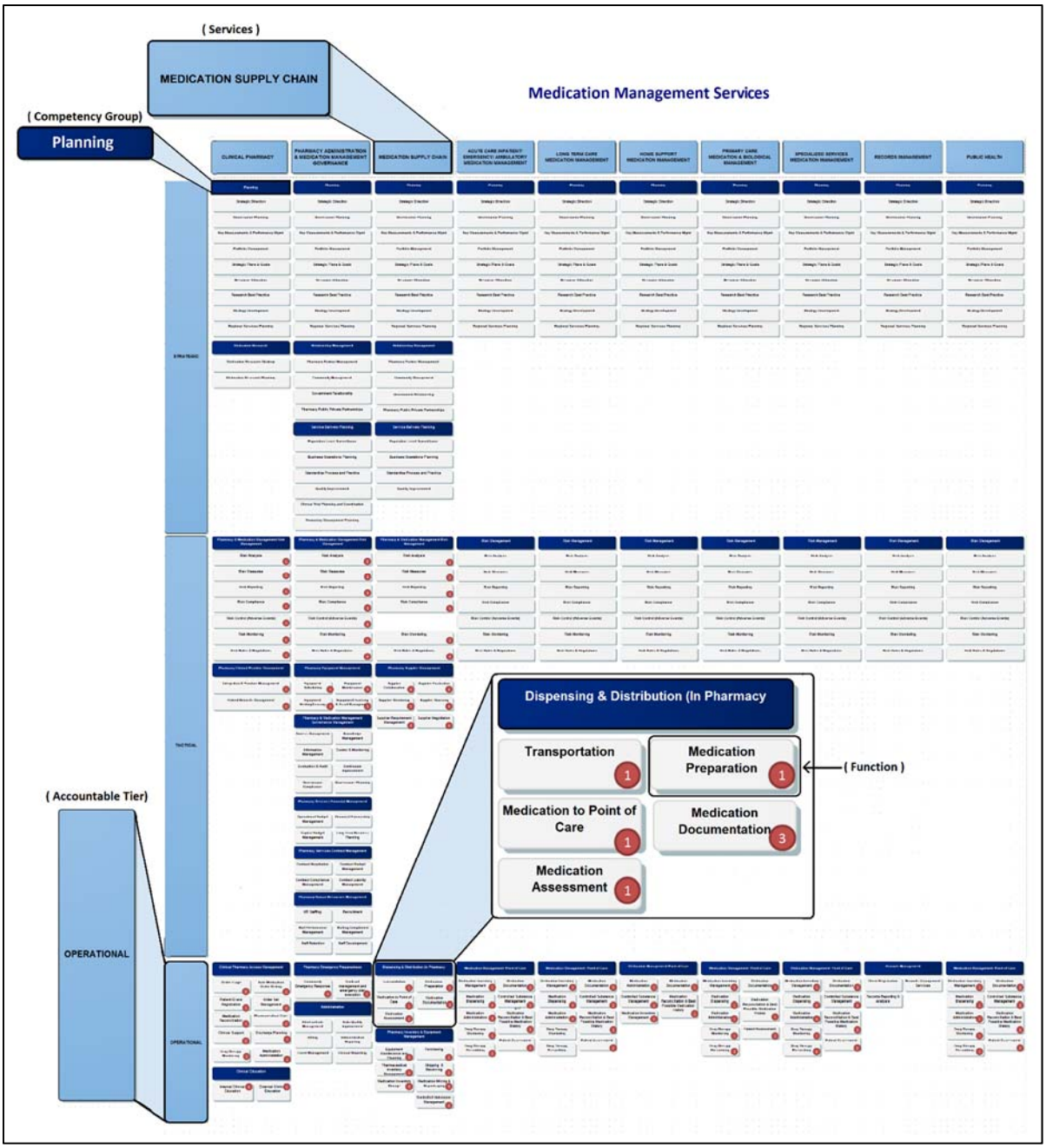


Figure 14 Business Competency Model

Appendix 13. Value Chain

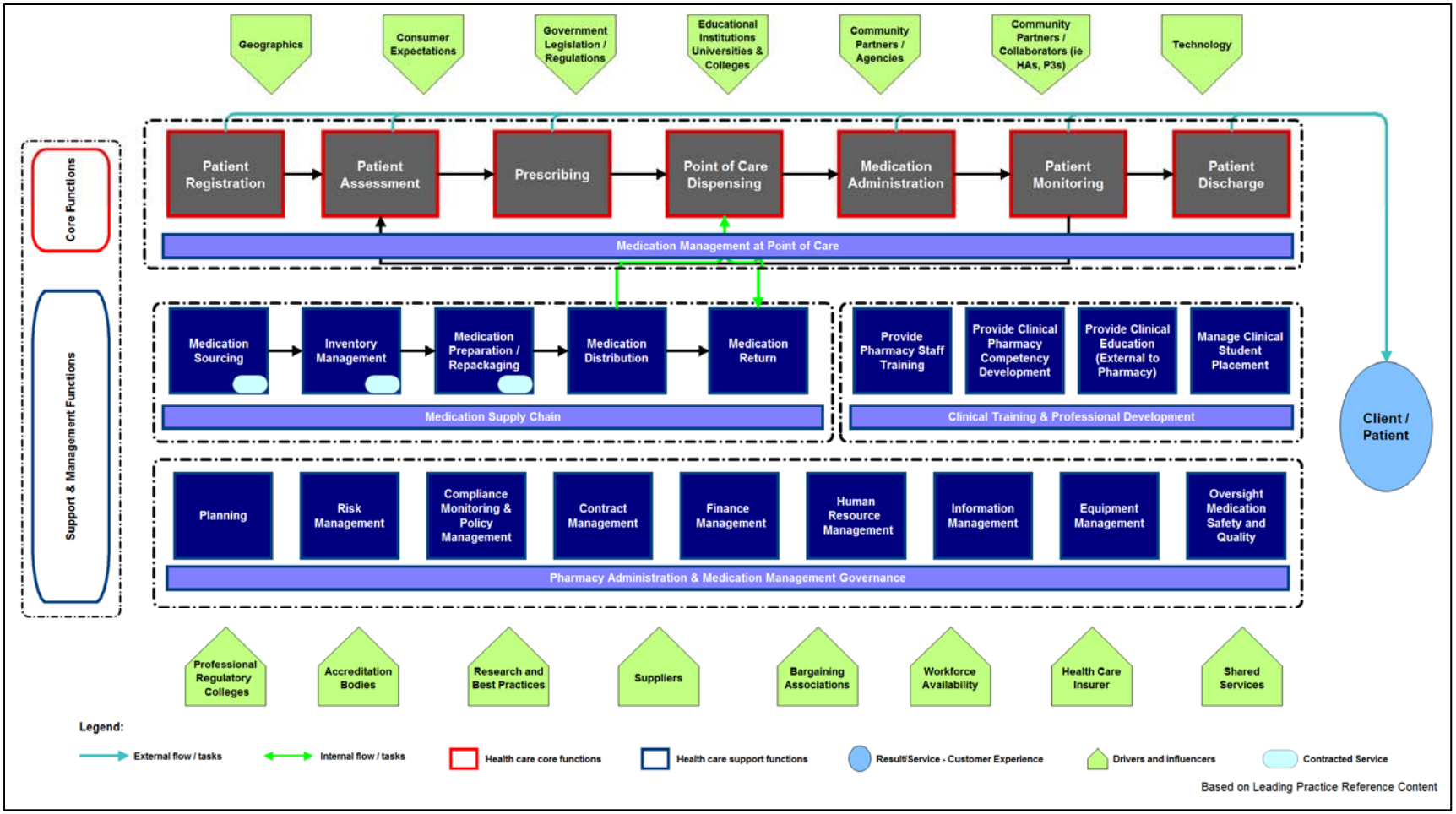


Figure 15 Value Chain

Appendix 14. Listing of Criteria Definitions

Criteria for Prioritization of Improvement Initiatives		
Criteria	*Criteria Questions*	Definition of Criteria
Business Continuity	What impact will this initiative have on department level stability and sustainability?	Department level stability and sustainability refers to the current operations and whether the process improvement proposed will jeopardize the ability of the department to meet its mandate in the long term.
	What impact will this initiative have on system stability and sustainability?	System stability refers to looking at the system as a whole and considers risk/benefit to other parts of the system. The proposed change will have a long standing impact on the system. Sustainability refers to the ability for the proposed service change to continue into the future.
Feasibility	What is the expected impact on Employee and/or Physician Engagement?	Impact from the perspective of our staff and physicians, on workplace environment including: 1) Teamwork and morale 2) Tools and equipment 3) Opportunities to Learn and Grow 4) Well-being and safety
	What number of employees and or physicians will be impacted by the proposed change?	Change management is a significant component of the feasibility of successful implementation. One of the major considerations in change is the number of individuals involved in the change.
	Is there organizational capacity to implement the initiative?	Challenges or Facilitators to the implementation of proposed initiatives based on the following: 1) Risks assessed 2) Barriers assessed 3) Mitigation Plan developed 4) Organizational experience in leading similar initiative 5) Experienced resource is readily available
Patient Safety	How will this initiative impact patient safety?	This criterion focuses on reduction in risk of harm to the patient/client from care/service being provided. Risk of harm and also potential degree of harm need to be considered. This criterion does not include factors that have been addressed in other criteria such as accessibility, continuum of care and upstream risk factors.
	# of patients/residents potentially affected	This criteria measures the number of patients/residents whose risk of an adverse event could potntially be impacted by the proposed change
	What level of evidence exists that improvements in selected process will reduce adverse events?	This criteria measures the level (quality) of evidence that the proposed intervention will result in the intended outcomes.
Worker Safety	How will this initiative impact worker safety?	This criterion focuses on reduction in risk of harm to workers in the workplace. Risk of harm and also potential degree of harm need to be considered. This criterion does not include factors that have been addressed in other criteria such as accessibility, continuum of care and upstream risk factors.
	The number of staff or physicians who could have an increase or decrease in work related injuries as a result of the proposed initiative?	This criteria measures the number of workers/physicians whose risk of a workplace injury or illness could potentially be impacted by the proposed change
Process Maturity	To what degree will the initiative result in an increase to process maturity across the system?	Process Maturity is measured on a scale of 1 to 5 with 1 being the most immature and 5 being the most mature. The level of process maturity in most cases should be at least at level 3. There are processes where it is feasible and desirable to get to level 5 maturity.
	Is the process one that needs to be standardized in order to take advantage of available automation opportunities?	Automation of workflow is known to be an effective strategy to increase efficiency and reduce errors however automation of poor processes can have the opposite impact. In order to take advantage of opportunities for automation of tasks the processes being automated need to be documented, standardized and monitored to ensure compliance with standardization prior to undertaking automation of the tasks.
Strategic Alignment	Is the process improvement directly related to NH three year strategic action plans?	NH has eight strategic action plans it has proposed to complete over the upcoming 3 years. The proposed process improvement could address more than one of these plans. Negative impact could be considered where the resources required to carry out the process improvement will be diverted away from working on the Strategic Action Plan elements.
Financial Impact	Is there an anticipated net savings to the organization?	This criterion refers to the optimal use of resources to yield maximum benefits and results. Evidence of estimated cost of alternative solutions considered should be included in the proposal documentation.

Table 20 Listing of Criteria Definitions

Appendix 15. Initiative Ranking

Initiative/Project Title:				Strategic Action Plan Ref #								
Rating	*Criteria Questions*	Criteria Weights	-3	-2	-1	0	1	2	3		*Rating*	*Weighted Score*
Business Continuity	**What impact will this initiative have on department level stability and sustainability?**		Significant negative impact at the department level with no strategy available to mitigate	Moderate negative impact on department level stability/ sustainability with strategy in place to address	Minimal negative impact at the department level is short term and has been addressed in the implementation plan	No impact on system stability/sustainability	minimal positive impact on department level stability/sustainability	Moderate positive impact on department stability/sustainability	Significant positive impact on department stability/sustainability			
	What impact will this initiative have on system stability and sustainability?		Significant negative impact at the system level with no strategy available to mitigate	Moderate negative impact on system level stability/ sustainability with strategy in place to address	Minimal negative impact at the system level is short term and has been addressed in the implementation plan	No impact on system stability/sustainability	Minimal positive impact on system stability/sustainability	Moderate positive impact on system stability/sustainability	Significant positive impact on system stability/sustainability			
Subtotal		6.48%									0	0.0000
Feasibility	**What is the expected impact on Employee and/or Physician Engagement?**		Negatively Impacts 4 of the 4 objectives	Negatively Impacts 2 - 3 of the 4 objectives	Negatively Impacts 1 of the 4 objectives	no impacts	Positively Impacts 1 of the 4 objectives	Positively Impacts 2 - 3 of the 4 objectives	Positively Impacts 4 of the 4 objectives			
	What number of employees and or physicians will be impacted by the proposed change?		Greater than 500 people affected	200 to 500 people affected	100 to 200 people affected	50 to 100 People affected	25 to 50 people affected	Less than 25 people affected	No people affected			
	Is there organizational capacity to implement the initiative?		Significant Risk to successful implementation and no opportunity for mitigation identified	Significant Risk to successful implementation and with some degree of mitigation identified	Moderate Risk to successful implementation and no opportunity for mitigation identified	Moderate Risk to successful implementation and a mitigation plan has been developed	Minimal Risk to successful implementation	Minimal Risk to successful Implementation and a mitigation plan has been developed	Risk Assessment has been completed and no risks have been identified			
Subtotal		7.63%									0	0.0000
Patient Safety	**How will this initiative impact patient safety?**		Potential of significant negative impact on patient safety	Potential of moderate negative impact on patient safety	Potential of minimal negative impact on patient safety	No impact on patient safety	Potential minimal positive impact on patient safety	Potential of moderate positive impact on patient safety	Potential of significant positive impact on patient safety			
	# of patients/residents potentially affected		greater than 10% of patients/residentshave potential to be negatively impacted	5 to 10% of patients/residents have potential to be negaively impacted	less than 5% of patients have potentiall to be negatively impacted	no impact to any residents or patients	less than 25% have potential to be positively impacted	25% to 50% have potential to be positively impacted	50% and greater have potential to be positively impacted			
	What level of evidence exists that improvements in selected process will reduce adverse events?		No evidence	clinical/expert Opinion	Local quality improvement results	Low reliability evidence (not peer reviewed)	Moderately reliable evidence	Highly reliable evidence exists in the form of peer reviewed studies.	Large randomized control trial results			
Subtotal		29.48%									0	0.0000
Worker Safety	**How will this initiative impact worker safety?**		Potential of significant negative impact on workplace safety	Potential of moderate negative impact on workplace safety	Potential of minimal negative impact on workplace safety	No impact on workplace safety	Potential minimal positive impact on workplace safety	Potential of moderate positive impact on workplace safety	Potential of significant positive impact on workplace safety			
	The number of staff or physicians who could have an increase or decrease in work related injuries as a result of the proposed initiative?		greater than 10% of workers/physicians potentially negatively impacted in respect to workplace safety	5 to 10% of workers/physicians potentially negatively impacted in respect to workplace safety	less than 5% of workers/physicians have potentially negative impact on workplace safety	no workers/physicians are expected to incur a change in likelihood of workplace injury or illness	less than 25% of workers/physicians potentially will be positively impacted in respect to workplace safety	25% to 50% of workers / physicians potentially will be positively impacted in respect to workplace safety	50% and greater of workers/physicians potentially will be positively impacted in respect to workplace safety			
Subtotal		28.89%									0	0.0000
Process Maturity	**To what degree will the initiative result in an increase to process maturity across the system?**		Process maturity will decrease to Level 1	Process maturity will decrease but not lower than Level 2	Process maturity will decrease but not lower than Level 3	No change in process maturity	Potential to move the process maturity level from level 1 to level 2	Potential to move the process maturity level from level 1 or 2 to Level 3	Potential to move the process maturity level above Level 3.			
	Is the process one that needs to be standardized in order to take advantage of available automation opportunities?		Implementation of initiative would result in disruption of current automation already in place without potential for remediation or	Implementation of initiative would result in disruption of current automation already in place with planned remediation or	Implementation of initiative would result in short term loss of automation .	Standardization of process would not result in efficency gains related to automation	Standardization of process is beneficial but automation opportunity minimally impacted	Standardization of Process is essential to implement future automation and realize efficiencies	Standardization of Process is essential to implement current automation opportunitites and realize efficiencies			
Subtotal		4.34%									0	0.0000
Strategic Alignment	**Is the process improvement directly related to NH three year strategic action plans?**		Expected to negatively impact the achievement of more than one element of the Strategic Action Plans	Expected to negatively impact the achievement of one element of the Strategic Action Plans	Identifed the potenital risk that it may delay acheivement of an element of the Strategic Action Plan	Not specifically related to any element within the Strategic Action Plan	Indirectly related to at least one element in the Strategic Action Plans	Directly addresses a Strategic Action Plan element	Addresses more than one element of Strategic Action Plans			0.0000
Subtotal		11.13%									0	0.0000
Financial Impact	**Is there an anticipated net savings to the organization?**		Significant (>$100k)net financial cost to the organization in annual operating expenses.	Moderate (between $50k and $100k) financial cost to the organization in annual operating expenses.	Minimal (<$50k) financial cost to the organization in annual operating expenses	No financial impact to the annual operating expenses	Minimal (<$50k) financial gain to the organization in annual operating expenses	Moderate (between $50k and $100k) financial gain to the organization in annual operating expenses.	Significant (>$100k)net financial gain to the organization in annual operating expenses.			0.0000
Subtotal		12.05%									0	0.0000
Total		100.00%									0.00	0.0000

Table 21 Initiative Ranking Tool

Appendix 16. Results of Prioritization of Improvement Initiatives

Medication Safety and Quality Improvement Initiatives			
3 Year Strategic Action Plans			
Ranked based on MCDA tool			
Focus	Proposal	Title	Rated Score
1. Medication reconciliation	#1-0001	1.1 Ensure standard clinical workflows and processes include BPMH and Med Rec at all transitions	617.5
3. Medication Prescribing	#1-0005	3.1 Ensure all medication orders adhere to Safe Medication Order Writing (SMOW)	586.3
4. Improve AMS	#1-0009	4.1 Develop and maintain AMS interdisciplinary committee to provide oversight and governance	586.3
4. Improve AMS	#1-0010	4.2 Implement standard processes to ensure improved AMS	586.3
4. Improve AMS	#1-0011	4.3 Establish and maintain process to collect and reporting AMS program metrics	586.3
3. Medication Prescribing	#1-0008	3.4 Facilitate clinical pharmacists involvement in prescribing decision making process	486.6
2. Comm care plan & POC	#1-0003	2.1 Med therapy is effectively communicated in plan of care appropriate patients	464.8
2. Comm care plan & POC	#1-0004	2.2 Med therapy is effectively communicated in care plans for appropriate patients	464.8
5. Medication Dispensing	#1-0016	5.5 Ensure timely and accurate verification and dispensing processes	457.8
8. Medication administration	#1-0026	8.5 Reduce the gap between current and best practice guidelines	424.7
7. Minimize inventory costs	#1-0020	7.1 Implement best practice standard inventory management processes	370.6
3. Medication Prescribing	#1-0006	3.2 Develop and maintain appropriate medication order sets	367.4
8. Medication administration	#1-0024	8.3 Implement quality assurance process for infusion pumps	363.1
3. Medication Prescribing	#1-0007	3.3 Conduct medication use evaluation (MUE) reviews to assess adherence to best practice	277.9
5. Medication Dispensing	#1-0012	5.1 Develop a regional central intravenous admixture (CIVA) plan compliant with standards	158.9
5. Medication Dispensing	#1-0013	5.2 Implement a regional CIVA plan compliant with standards	158.9
8. Medication administration	#1-0022	8.1 Ensure safe handling of hazardous drugs according to provincial guidelines	95.4
Initiatvies Not Ranked			
1. Medication reconciliation	#1-0002	1.2 Establish quality assurance processes related to BPMH and Med Rec	mandatory
6. Increase standarization	#1-0019	6.3 Achieve maturity level 3 or above for identified critical processes	critical processes not identified
7. Minimize inventory costs	#1-0021	7.2 Manage drug shortages in order to minimize patient impact	mandatory
8. Medication administration	#1-0025	8.4 Establish process for monitoring use of AMDC access using Knowledge Portal	audit function
Inititatives completed prior to Ranking exercise			
5. Medication Dispensing	#1-0014	5.3 Develop ranking tool for Automated Medication Dispensing Cabinets and apply to all facilitites	complete
5. Medication Dispensing	#1-0015	5.4 Implement AMDCs in accordance with the ranking tool	complete
6. Increase standarization	#1-0017	6.1 Develop service model for provision of pharmacy services to residential LTC facilities	complete
6. Increase standarization	#1-0018	6.2 Implement service model for provision of pharmacy services to residential LTC facilities	complete
8. Medication administration	#1-0023	8.2 Implement regional standard for infusion pumps	complete
8. Medication administration	#1-0027	8.6 Develop neonatal parenteral therapy manual	complete
8. Medication administration	#1-0028	8.7 Implement neonatal parenteral therapy manual for use in Northern Health	complete
8. Medication administration	#1-0029	8.8 Establish audit processes for quality assurance of narcotic handling outside pharmacy	complete

Table 22 Results of Prioritization of Improvement Initiatives

Appendix 17. Reporting Frequency

Proposed Reporting Frequency of Available Indicators

Adhoc

% compliance with privacy and confidentiality audits
# of Patient assessments completed by pharmacists or pharmacy technician
% of nurses who have completed SMOW education module
% of pharmacists who have completed SMOW education module
% of pharmacy technicians who have completed SMOW education module
% of physicians who have completed SMOW education module
% of unit clerks who have completed SMOW education module

Annual

# of clinical pharmacy hours per 100 inpatient days
# of Medication Utilization Reviews Completed Annually for AMS;
# of medical students receiving clinical education during their 3rd year rotation
# of pharmacy residents in NH
# of pharmacy technician students receiving education annually
% of facilities with infusion pumps meeting established standard
% of identified critical processes with process maturity level 3 or above
% of meetings where all NH representatives attended
% of facilities dispensing patient specific medications on 24 hour batch
% of formulary reviews completed by NH
% of staff/physicians accessing education opportunities
% oral solid meds with bar code on unit dose packaging;
Reported patient satisfaction on medication education provided
Reported patient satisfaction with pain management during hospital stay
Worklife Survey - level of satisfaction
# of pharmacist clinical training weeks provided
% of pharmacists who meet competency measures for clinical pharmacy

Period

# of interventions per hour clinical pharmacist time
% of discrepancies (requiring intervention) found after/during medication reconciliation
% of VTE audits where patients received appropriate prophylaxis
% of patients with Med Rec Completed within 24 hours of admission
Cost of expired drugs for credit
Total Cost of Expired Drugs

Quarterly

# of average turns of inventory
# of IV to PO step-down interventions
# of anti-infective Drug Therapy Problems resolved per inpatient admission

# of medication doses administered in error per PSLS resulting in harm level greater than or equal to level 3 harm
# of resolved drug therapy problems per 100 outpatient visits
# of resolved drug therapy problems per 100 resident days
# of Resolved DTPs per 100 inpatient admissions
%of Interventions accepted in prospective audit and feedback regarding antibiotics
% of individuals expected to complete SMOW education who have taken SMOW
% of medication orders entered accurately as assessed by pharmacist at verification
Actual inventory value or estimate based on Value on Hand reported in Cerner for all NH Pharmacies
Average Length of Stay per acute inpatient admission
Cost of antimicrobials per 100 inpatient days
Cost of expired drugs as percentage of drug budget
Cost of expired drugs not for credit as a % of total expired drugs
Cost of IV antibiotics per 100 inpatient days
Cost of oral antibiotics per 100 inpatient days
Defined Daily Dose (DDD) per 100 patient days for targeted antibiotic
Drug Cost per 100 inpatient days
Drug cost per 100 resident days in LTC facilities (non Plan B)
Drug Costs per inpatient day
High cost antineoplastic drug utilization in pharmacy
Turnaround time of internal medication inventory transfers based on established benchmark standards.
% of orders compliant with Safe Medication Order Writing (SMOW)
% of reported errors per orders entered as per PSLS reports

Semi-annual

# of physician specific order sets;
# of active order sets that are up to date
# of regional order sets;
# of site specific order sets
# of incident reports of staff exposure
% of meds delivered late per PSLS reports
% of alignment NH formulary to Provincial formulary
% of medications accessed through AMDC on over-ride
% of patients educated on Medications by a pharmacist
Average Turnaround time of medications from order scan to release of medication (Pyxis)
Door to needle time for thrombolytic

Appendix 18. Process Reference Model

- **1 Manage Medication at Point of Care**
  - **1.1 Register Patient**
    - 1.1.1 Enroll Patient in Appropriate Information System
    - 1.1.2 Confirm Patient Identification and Identify for Clinical Pharmacy Services
  - **1.2 Assess Patient**
    - 1.2.1 Interview Patient
    - 1.2.2 Order Diagnostic Tests
    - 1.2.3 Interpret Results of Diagnostic Tests
    - 1.2.4 Diagnose Patient
  - **1.3 Prescribe Medication**
    - 1.3.1 Conduct Best Possible Medication History Interview
    - 1.3.2 Conduct Medication Reconciliation
    - 1.3.3 Order Medication
    - 1.3.4 Triage medication orders
    - 1.3.5 Perform Clinical assessment of medication order
  - **1.4 Dispense Medication at Point of Care**
    - 1.4.1 Maintain Point of Care Inventory
    - 1.4.2 Manage Patient Owned Medications
    - 1.4.3 Dispense Medication
  - **1.5 Administer Medication**
    - 1.5.1 Prepare medication if required
    - 1.5.2 Administer Medication to Patients
    - 1.5.3 Complete Medication Administration Record
  - **1.6 Monitor Patient**
    - 1.6.1 Provide Pharmaceutical Care to Patients
    - 1.6.2 Deliver Patient Education on Medication Therapy
    - 1.6.3 Monitor Patient Response to Medication Therapy
  - **1.7 Transfer or Discharge Patient**
    - 1.7.1 Plan for Patient Discharge
    - 1.7.2 Discharge Patient
- **2 Provide Clinical Training & Professional Development**
  - **2.1 Provide Pharmacy Staff Training**
    - 2.1.1 Identify Training Needs
    - 2.1.2 Develop Training Materials
    - 2.1.3 Deliver Training
    - 2.1.4 Monitor Learner Progress and Provide Feedback
    - 2.1.5 Monitor Training Effectiveness
  - **2.2 Provide Clinical Pharmacy Competency Development**
    - 2.2.1 Establish Clinical Pharmacy Competencies
    - 2.2.2 Develop Competency Evaluation
    - 2.2.3 Develop Competency Training

2.2.4 Deliver Clinical Pharmacy Training
2.2.5 Monitor Learner Progress & Provide Feedback
2.2.6 Monitor Training Effectiveness

2.3 Provide Clinical Education(External to Pharmacy)

2.3.1 Identify Training Needs
2.3.2 Develop Training Materials
2.3.3 Deliver Training
2.3.4 Monitor Learner Progress and Provide Feedback
2.3.5 Monitor Training Effectiveness

2.4 Manage Clinical Student Placement

2.4.1 Engage with Education Providers
2.4.2 Identify Potential Candidates & Make Selection
2.4.3 Develop Training Plan
2.4.4 Monitor Student Progress & Provide Feedback
2.4.5 Evaluate Effectiveness of Training Plan

3 Manage Medication Supply Chain

3.1 Source Medication

3.1.1 Establish & Maintain Supplier Requirements
3.1.2 Evaluate and Approve Potential Suppliers
3.1.3 Identify and Maintain Supplier List
3.1.4 Negotiate with Suppliers
3.1.5 Collaborate with Suppliers
3.1.6 Monitor Supplier Performance
3.1.7 Perform Analysis and Response to Drug Shortages
3.1.8 Purchase Medication
3.1.9 Receive purchased medication
3.1.10 Initiate Payment
3.1.11 Pay Suppliers

3.2 Maintain Medication Inventory

3.2.1 Define Inventory Strategies
3.2.2 Define Inventory Demand
3.2.3 Create Inventory Plan
3.2.4 Define Performance Metrics
3.2.5 Establish Standards for Medication Storage
3.2.6 Ship Inventory to secondary inventory locations
3.2.7 Store purchased medication
3.2.8 Monitor medication storage procedures
3.2.9 Perform Inventory Count

3.3 Mix & Repackage Medication

3.3.1 Issue components from inventory
3.3.2 Compound Medications Outside Laminar Hood
3.3.3 Compound Medications within Laminar Hood
3.3.5 Add Compounded Medications to Inventory

3.3.6 Remove bulk packaged goods from inventory location
3.3.7 Repackage into single use doses
3.3.8 Restore unit dose packages in inventory
3.3.9 Repackage medications for 24 hour Batch (patient specific)
3.3.10 Pick medication from inventory
3.3.11 Issue medication from perpetual inventory

3.4 Distribute Medication

3.4.1 Transport purchased medication to secondary inventory location
3.4.2 Document Patient Specific Medication Orders
3.4.3 Verify Patient Specific Medication Orders
3.4.4 Dispense Patient Specific Medication
3.4.5 Replenish Ward Stock

3.5 Return Medication

3.5.1 Identify expired medications in Pharmacy Inventory
3.5.2 Return Expired Drugs to Pharmacy
3.5.3 Return Expired Drugs eligible for refund to Suppliers
3.5.4 Dispose of expired controlled substances
3.5.5 Dispose of expired medications

4 Manage & Administrate

4.1 Plan

4.1.1 Develop Strategic Plan & Goals
4.1.2 Establish Portfolio Priorities
4.1.3 Establish Governance Plans
4.1.4 Allocate Resources
4.1.5 Develop Strategy for Pharmacy & Medication Management
4.1.6 Establish Population Level Surveillance Plan
4.1.7 Develop & Communicate Regional Services Plan
4.1.8 Plan Research Strategy
4.1.9 Develop Medication Research Strategy
4.1.10 Establish Formulary Management Plan
4.1.11 Establish Business Operating Plan
4.1.12 Establish Standards for Pharmacy & Medication Management
4.1.13 Establish Plan for Clinical Trials
4.1.14 Identify Quality Improvement Plan
4.1.15 Plan for long term business operations
4.1.16 Establish Performance Measurement Plan
4.1.17 Maintain Drug Formulary

4.2 Manage Risk

4.2.1 Establish Risk Analysis Framework
4.2.2 Establish Risk Measures
4.2.3 Establish Risk Monitoring Plan
4.2.4 Establish Risk Reporting
4.2.5 Establish & Maintain Response to Adverse Events

4.2.6 Establish & Maintain Risk Rules & Regulations
4.2.7 Establish & Manage Risk Compliance

4.3 Monitor Compliance

4.3.1 Manage and Monitor Progress related to Governance Plan
4.3.2 Establish Compliance Plan and Reporting
4.3.3 Validate medication orders adhere to Safe Medication Order Writing
4.3.4 Document receipt, administration and disposal of controlled substances
4.3.5 Document receipt, administration and disposal of controlled substances
4.3.6 Monitor & Control compliance with Policies & Procedures
4.3.7 Evaluate & Audit effectiveness of Policies & Procedures

4.4 Manage Contracts

4.4.1 Negotiate contracts
4.4.2 Manage contract Budget
4.4.3 Evaluate and monitor contract liability
4.4.4 Evaluate and monitor contract performance and compliance

4.5 Manage Human Resources

4.5.1 Identify Human Resource Requirements
4.5.2 Recruit Staff to meet Identified Needs
4.5.3 Recruit Staff to identified Needs
4.5.4 Orientate Staff
4.5.5 Schedule Staff
4.5.6 Manage Staff Performance
4.5.7 Manage Staff Recognition Program

4.6 Manage Financial Resources

4.6.1 Identify Operating Budget Requirements
4.6.2 Monitor Operating Expenditures
4.6.3 Initiate Operating Budget Remediation Actions
4.6.4 Identify Capital Budget Requirements
4.6.5 Monitor Capital Expenditures
4.6.6 Initiate Capital Budget Remediation Actions
4.6.7 Forecast operating and capital budget performance
4.6.8 Initiate Accounts Receivable
4.6.9 Collect Accounts Receivable
4.6.10 Manage Employee Travel Expenses

4.7 Manage Information

4.7.1 Establish Information System Standards
4.7.2 Manage Information System Access
4.7.3 Manage Patient Records
4.7.4 Monitor & Improve Data Quality
4.7.5 Maintain clinical pharmacy patient record
4.7.6 Maintain Medication information resources
4.7.7 Maintain Inventory Data
4.7.8 Manage Master Drug Library for Infusion Pumps

4.7.9 Develop and Maintain medication order sets
4.7.10 Develop & Maintain Performance Monitoring Reports

4.8 Procure & Maintain Equipment & Facilities

4.8.1 Establish & Manage Equipment Schedule
4.8.2 Procure Equipment through Renting or Leasing Option
4.8.3 Establish & Manage Plan for Equipment Maintenance
4.8.4 Establish & Maintain Asset Tracking Policies & Procedures

4.9 Provide Operational Oversight

4.9.1 Establish and Manage Partnerships
4.9.2 Establish & Manage Provincial Government Relationship
4.9.3 Establish & Manage Municipal Government Relationships
4.9.4 Establish & Manage Public Private Partnerships
4.9.5 Establish & Staff Pharmacy Hours of Operation
4.9.6 Promote continuous Improvement
4.9.7 Implement and Maintain Anti-Microbial Stewardship Program
4.9.8 Promote Integration & Practice Management
4.9.9 Develop & Maintain Community & Emergency Response Plan
4.9.9 Research Best Practice
4.9.10 Establish Emergency Response Policies & Procedures
4.9.11 Manage Fleet Vehicles
4.9.12 Develop & Monitor Administrative Reports
4.9.13 Develop & Monitor Clinical Reports
4.9.14 Develop & Publish Performance Reports

Table 23 Process Reference Model

Appendix 19. Listing of Functions with Definitions

STRATEGIC LEVEL FUNCTIONS	
Pharmacy & Medication Management Planning	
Strategic Direction	Development of an operational strategic course of action that leads to the achievement of organizational strategic objectives
Strategic Plan and Goals	Development and definition of strategic actions and targets for achievement of the operational strategic direction
Resource Allocations	Development and management of a plan for assigning and managing available resources (human resources, hardware, etc.) for optimizing operations.
Pharmacy & Medication Management Governance Planning	Executive and Board governance planning to ensure long term safety and effectiveness of mediation management both in the pharmacy and throughout the organization.
Research Best Practice	Identifying superior methods of achieving a
Portfolio Management	Centralized management of one or more portfolios which includes identifying, prioritizing, authorizing, managing and controlling programs and other related work to achieve strategic business objectives
Key Measurements and Performance Indicators	Establish and monitor business metrics used to evaluate operational factors that are crucial to the success of the organization and align with organizational strategic goals.
Pharmacy & Medication Management Strategy Development	Identifying objectives and the (strategies) means that will be undertaken to achieve those objectives
Regional Services Planning	Planning for pharmacy services across the region of particular importance is how pharmacy services will be provided to small sites who do not have on site pharmacists.

Medication Research	
Medication Research Strategy	Providing an environment of opportunities, options and methodologies for appropriate research (as well as continual development of channels for application of research findings) that meet applicable ethics and standards
Medication Research Planning	Establishing research objectives, types (quantitative and qualitative), and processes for research in work environment.
Relationship Management	
Pharmacy Partner Management	Management of relationships, communications and services with internal and external stakeholders and partners
Government Relationship	Organizational representation / stakeholder participation, communication development and coordination of policy and legislative efforts by local, provincial and federal governments
Community Management	
Pharmacy Public-Private Partnership	Development and management of long term contracts between a private party and a governmental entity for providing a public service
Service Delivery Planning	
Population Level Surveillance	Surveillance of medication usage and potential need at the population level
Formulary Management Planning	Setting objectives, policies and processes for establishing and maintaining medication formulary to be used in the organization.
Business Operations Planning	Establishing objectives, policies and processes for maintaining or adjusting service levels for medication management.
Standardize Process and Practice	Continuous improvement and implementation of evidence based practices within medication management
Clinical Trial Planning and Coordination	Establishing objectives, policies and processes when medication related clinical trials are being conducted within the organization.
Quality Improvement	The practice of monitoring, evaluating and improving the quality of services provided.

TACTICAL LEVEL FUNCTIONS	
Pharmacy & Medication Management Risk Management	
Pharmacy & Medication Management Risk Analysis	Defining and analyzing the dangers to individuals or business posed by a potential natural and/or human-caused adverse event
Pharmacy & Medication Management Risk Measures	Statistical measures to assess performance to its benchmark index within and accepted standard deviation
Pharmacy & Medication Management Risk Monitoring	Control projects applied to monitor identified risks, identify new risks, and ensure proper execution of planned risks
Pharmacy & Medication Management Risk Reporting	Development and implementation of a risk measurement performance and reporting framework
Pharmacy & Medication Management Risk Control (Adverse Events)	Proactively identify and respond to manage, reduce or eliminate risk
Pharmacy & Medication Management Risk Rule & Regulations	Rules and regulations that are identified and applied to mitigate, manage risk
Pharmacy & Medication Management Risk Compliance	Management of process which identify the applicable requirements (defined in laws, regulations, contracts, strategies and policies), assessment of the state of compliance to confirm with requirements, and initiation of any corrective actions deemed necessary
Equipment Management	
Equipment Scheduling	The booking and scheduling of equipment as requested/required
Equipment Renting/Leasing	Managing rental or short term usage agreements of required equipment that is not owned by the organization
Equipment Maintenance	Managing, scheduling and monitoring of equipment maintenance requirements as defined within standard operating agreements or recommended maintenance schedules.

Equipment Tracking & Asset Management	Management and monitoring of equipment inventory, frequency of use, and evaluation of equipment life cycle requirements
Supplier Management	
Supplier Collaboration	Joint pursuit of competitive advantages for the parties involved with appropriate parties working together to maximize the benefit for all.
Supplier Sourcing	Proactive management of a supply market to identify relevant and potential suppliers that meet organizational objectives and ensure access to adequate resources required for the long term needs of the organization.
Supplier Requirement Management	Management of specifications to optimize external resources to frame agreement with suppliers.
Supplier Evaluation	Assessment of potential suppliers (product quality, cost and ability to meet demand) to meet organizational needs, policies, and budgets.
Supplier Monitoring	Ongoing evaluation of supplier's ability to meet organizational needs, policies and value for money.
Supplier Negotiation	Setting of objectives, development of strategy, understanding supplier's ability to meet objectives, and development supplier and cost agreements.
Pharmacy & Medication Management Governance Management	
Pharmacy & Medication Management Access Management	Establishing criteria for admission to service including routine hours of operation, and processes to access after hour services where applicable.
Pharmacy & Medication Management Information Management	The custodianship, quality, security and distribution of information to people or systems who need/use it.
Pharmacy & Medication Management Governance Planning	Efforts by managerial level to ensure governance requirements are included in planning activates related to medication management.
Pharmacy & Medication Management Governance Compliance	Monitoring of compliance with standards established in governance plan.
Pharmacy & Medication Management Knowledge Management	Capturing, distributing and effectively using knowledge

Pharmacy & Medication Management Governance Control & Monitor	Review and evaluate processes for preventing an unacceptable level of uncertainty in business objectives
Pharmacy & Medication Management Governance Evaluation & Audit	Systematic review of processes to improve the effectiveness of risk management and control.
Pharmacy & Medication Management Continuous Improvement	Quality management that focuses on process, rather than individual, recognizing both internal and external stakeholders and promoting the use of objective data to analyze and improve processes.
Pharmacy Clinical Practice Management	
Integration & Practice Management	Clinical pharmacist efforts to work with other care providers to maximize benefits of medication therapy.
Patient Records Management	Clinical Pharmacists records related to patient care which are not part of the patient chart which eventually are used for Data Abstract Discharge purposes.
Pharmacy Services Financial Management	
Operational Budget Management	Analysis, organization and oversight of costs and expenditures for an organizational business unit
Capital Budget Management	Analysis, evaluation and oversight of cost, expenses and potential investments for organizational business unit plant and equipment over a period greater than a year.
Forecasting	Use of historic data and current plans to determine the direction of future trends
Long term business planning	
Pharmacy Services Contract Management	
Contract Negotiations	Discussing points of potential partnership arrangement to meet organizational goals under a formalized terms of agreement.
Contract Budget Management	Planning, managing and controlling costs against an agreed budget
Contract Liability Management	Management of contracts against organizational governance documents such as operating agreements, employment agreements, contractor agreement, licensing agreements, etc.

Contract Compliance Management	Management and monitoring of key components in achieving compliance, managing risks, and enhancing performance of vendors, partners and employees related to a contract.
Pharmacy Human Resources Management	
Human Resource Staffing	Staffing management includes utilizing HR information, tools, procedures, guidelines and providing advice to employees related to staffing. Ensuring that the hiring of right people when and where they are needed, respecting the values of fairness, transparency, access and representativeness.
Staff Performance Management	Develop, manage and routinely evaluate staff ability to meet role performance expectations. Provide recognition directly to employees individually or organizationally where/ when appropriate. Effectively support employee through appropriate corrective action if required, i.e. review of role expectations, appropriate disciplinary steps, labour relations, attendance management, etc.
Retention	Ensure working environment supports current staff to remain and develop within an organization
Staffing Compliment Management	Identifying human resources needs and effectively managing the scheduling of the staff.
Recruitment	Attracting, selecting and appointing suitable candidates for jobs (permanent, temporary or casual). Could also include choosing suitable candidates for volunteer positions or trainee roles.
Staff Development	Managing, mentoring and providing support/leadership for common learning to enable a healthy workplace which supports continuous employee learning, formal and informal, and the application of new knowledge and skills to the workplace.

OPERATIONAL LEVEL FUNCTIONS	
Clinical Pharmacy Access Management	
Order Triage	Sequencing of medication orders
Patient ID and Registration	Identifying patients who will be provided with clinical pharmacy services
Medication Reconciliation	Reconcile patient's medication through effective interview techniques and record review including documenting best possible medication history.
Clinical Support	Provision of clinical pharmacy expertise to selected patients
Safe Medication Order Writing	Ensuring the appropriate documentation of medication orders to minimize risk of incorrect interpretation of the medication order.
Order Management	Manage medication orders to optimize medication therapy.
Diagnostic & Treatment Activities Coordination	Coordinate diagnostic testing and treatment related to medication therapy.
Emergency Preparedness	
Community Emergency Response	Ensuring that patients have access to needed medications when the supply chain is affected
Contract Management and emergency execution	Manage contracts during an emergency such as shortages of critical medications
Inventory and Equipment Management	
Equipment Maintenance and Cleaning	Maintenance and cleaning of medication related equipment such as Automated Medication Dispensing Cabinets and medication infusion pumps
Pharmaceutical Inventory Management	Manage centralized inventory of medications
Medication Inventory storage	Establishing appropriate storage of medication to ensure access and safekeeping of medications
Purchasing	Purchase of medications and related equipment
Shipping and Receiving	Receipt of ordered goods and shipping to other facilities where medication inventory is located.

Transportation	Transporting medication within a site from central pharmacy to point of care
Medication Distribution	Distributing medication to point of care
Medication Assessment	Assessment of medication orders to determine whether there are any problems with the medication order. Complete and appropriate.
Medication Documentation	Document on the patients file when drugs are administered
Medication Preparation	Prepare medication including repackaging or compounding.
Medication Administration	Administer medication to patient
Drug Therapy Monitoring	Monitor patient to ensure medication therapy is achieving the desired outcome.
Discharge Planning	Plan with the patient and physician for discharge
Education	
Internal clinical education (Pharmacy)	Development and delivery of clinical education to staff within the pharmacy.
Internal clinical education for non-pharmacy staff	Development and delivery of clinical education specific to medication management to staff outside the pharmacy such as nurses, and physicians.
External clinical education	Development and delivery of clinical education and practicum experience for clinical students such as pharmacy residents.
Administration	
Fleet Vehicle Management	Manage access for staff to use fleet vehicles
Billing	Generating and transferring information for billing purposes to Finance department.
Travel Management	Manage staff travel including authorization and reconciliation of travel expenses
Data Quality Improvement	Improve the quality of data at source
Administrative Reporting	Ensure that where applicable administrative reporting meets organizations expectations.
Clinical Reporting	Ensure clinical reporting meets standards.

Table 24 Listing of Functions with Definitions Source NH internal documents