User-Centered Change Management Process for CPOE Implementation

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Abstract

In response to a changing world, the healthcare domain is transforming to become increasingly digital. Technology is introduced to address healthcare challenges such as rising healthcare costs, ageing population, and adverse events. One of the significant examples of digital healthcare transformation is the implementation of *Computerized Provider Order Entry* (CPOE). CPOE is a system in which orders are placed electronically by providers and then transmitted directly to the recipient. The implementation of a CPOE system is a challenging process for any healthcare organization. It requires a dramatic change not only to the way care is provided but also to the way clinicians work. The complexity of the CPOE system implementation emanates from the need to manage the people side of the project and convince them to change their behaviours to use the system and generate results. Considering a CPOE system implementation project as successful requires the technology to work on time and within budget, together with users changing their behaviours and effectively using the new system to its full potential.

Typically, organizations' primary focus during the CPOE system implementation is on technology implementation rather than being a strategic focus on users. The literature includes many articles that emphasize the importance of involving users, physicians in particular, during every step of the CPOE implementation and how this involvement is necessary for the implementation success. However, most, if not all the articles, are considering users' participation during the *design* phase of the system and not during the *change management plan development*. Even if users' involvement during the change is mentioned, there is no exact way to attain this involvement, and the principles that govern this involvement remain imprecise and difficult to operationalize. Healthcare organizations need a step-by-step CPOE change management guidance (a roadmap) that considers the needs and requirements of end-users to gain their acceptance of the system and realize its maximum benefits.

To prepare users for the change and enhance their acceptance of the CPOE system, this thesis introduces a new *User-Centered Change Management* (UCCM) process. This

process aims to create an appropriate environment for healthcare organizations to successfully implement a CPOE system and achieve meaningful transition and use of the implemented system. The UCCM process combines change management (specifically, Kotter's model) and user-centered design (UCD) approaches. The UCCM process is validated with a retrospective case study and a comparative evaluation. The contributions of this thesis are:

- **Major contribution:**

  A user-centered change management (UCCM) process that helps healthcare organizations implementing a CPOE system by planning and managing the change accompanying such implementation. The UCCM process includes:

  - A process that combines UCD and change management approaches.
  - A customizable guide that can be adjusted to meet the needs of different users, organizations, and clinical settings.
  - A systematic change process that makes users the center of the change.
  - Survey examples that can help:
    a. Collect user requirements to improve their acceptance of the CPOE system. This survey was deployed as a pilot.
    b. Measure users' satisfaction with the change management plan, after the CPOE implementation.

- **Minor contribution:**
  - A list of factors that can affect users' acceptance of the CPOE system.

Dedication

To my ever-loving husband *Abdullah*; your unwavering support and sacrifices never go unnoticed. “Thank you” is not enough to express how grateful I am for your presence in my life.

Acknowledgment

At the outset, I would like to express my sincere and deepest gratitude to my husband *Abdullah* for his listening ear and encouragement. Your support and understanding kept me going. My son *Mohammad*, I am very fortunate to be your mom. I am beyond thankful for your sweet smile that gives me the power to keep going. I love you.

My great parents, *Hanan and Mohammed*, no words can describe how thankful, happy, and grateful I am for being your daughter. Your love and support mean the world to me. You are not only great parents but also amazing grandparents for *Hammodi*. I could not have asked for better grandparents for him. My siblings, *Mohannad, Enas, Moayad*, and *Monther*, you are who I can always count on no matter what. Thank you for being the best siblings and babysitters.

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“Any change, even a change for the better,
is always accompanied by drawbacks and discomforts.”

Arnold Bennett

Table of Contents

List of Figures

List of Tables

List of Acronyms

Acronym	Definition
AbPI	Activity based Process Integration
ADE	Adverse Drug Event
CADA	Chinese Aged Diabetic Assistant
CAS	Complex Adaptive Systems
CDSS	Clinical Decision Support System
CHIT	Consumer Health Informatics Technology
CHP	The Children's Hospital of Pittsburgh
CIHI	Canadian Institute for Health Information
CIS	Clinical Information System
CPOE	Computerized Provider Order Entry
DSRM	Design Science Research Methodology
ED	Emergency Department
EHR	Electronic Health Records
EMR	Electronic Medical Records
EY	Ernst & Young
HAMAC	The Health Authority Medical Advisory Committee
HCD	Human-Centered Design
HIT	Health Information Technology
ICT	Information and Communications Technologies
ICU	Intensive Care Unit
IDT	Innovation Diffusion Theory
IT	Information Technology
LFU	Low-Frequency Users
MSA	The Nanaimo Medical Staff Association
NHS	UK's National Health Service
NRGH	Nanaimo Regional General Hospital
POESUS	Physician Order Entry User Satisfaction and Usage Survey
RACI	Responsible, Accountable, Consulted and Informed
REB	Research Ethics Board
SCT	Social Cognitive Theory
TAM	Technology Acceptance Model
TAM2	Extended Technology Acceptance Model
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
UCCM	User-Centered Change Management
UCD	User-Centered Design
UCI	User-Centered Implementation
UDD	User-Driven Development
UTAUT	Unified Theory of Acceptance and Use of Technology

Chapter 1. Introduction

This thesis contributes a new *User-Centered Change Management* (UCCM) process. The UCCM process targets the development of a change management plan that focuses on users and makes them the center of the change during the implementation of a *Computerized Provider Order Entry* (CPOE) system in healthcare organizations.

In this chapter, I discuss the motivation, the problem context, as well as the research objectives, assumptions, and questions. I also present the research methodology I used to conduct the research, together with the main contributions, publications, and structure of this thesis.

1.1. Motivation

In response to the changing world, the healthcare domain is transforming to become increasingly digital. Technology is introduced to address healthcare challenges such as rising healthcare costs, ageing population, and adverse events such as medical errors and complications. As a result, policymakers are increasingly promoting the adoption of health information technologies (HIT) [1], [2]. HIT adoption decision is often made based on the optimism that HIT implementations will decrease costs, increase the quality of care, and reduce errors [3]–[5].

One of the significant examples of digital healthcare transformation is *Computerized Provider Order Entry* (CPOE). CPOE is a system in which orders are placed electronically by providers and then transmitted directly to the recipient. Originally, CPOE systems were developed to improve the safety of medication orders; however, newer systems now allow electronic ordering of tests, procedures, and consultations as well [6].

The introduction of CPOE systems has transformed healthcare substantially and improved its quality. The benefits of CPOE systems go beyond allowing clinicians to enter orders directly into a computer rather than handwriting them. A CPOE system introduces clinical decision support into daily practice to provide dosing guidance, reduce errors, and

increase quality. Furthermore, a CPOE system facilitates the standardization of healthcare practices, improves communication between different departments, accelerates patient transfers, and provides a platform to collect data for research, management, and monitoring [7]–[9]. More details about CPOE systems and their benefits are presented in Section *2.1*.

Despite all the reported benefits of such systems, their adoption rate does not meet expectations [5], [10]–[13]. CPOE systems face many barriers that impede their implementation. The start-up capital cost of implementation, as well as the ongoing operating costs, are at the top of barriers lists [8], [12]. An in-depth look at the literature about CPOE implementation barriers reveals that issues can be categorized either as organizational or technical barriers. Organizational barriers are those related to how organizations manage the change that comes with the CPOE implementation. Technical barriers are related to system usability, ease of use, and ability to integrate effectively with legacy systems. This thesis's focus is on the *organizational* side of the CPOE implementation process, so technical barriers are out of scope.

The implementation of a CPOE system is a complicated transformation project that impacts the workflows and processes of healthcare organizations. McCarthy and Eastman [14] portrayed an *Electronic Health Record* (EHR) implementation, which is comparable in many ways to a CPOE system implementation, like a tornado "in that it whips through an organization, turning life upside down and throwing users into a world filled with new ways of doing things and seeking ways to recapture some sense of balance and control". In general, the implementation of IT projects consists of three critical components: *people*, *process*, and *technology*. A look at the literature reveals that technology projects implementation failure is mostly a result of low users' adoption of the technology (*people*) and not a failure of the software (*technology*) [15]. The complexity of the CPOE system implementation emanates from the need to manage the people side of the project and convince users to change their behaviours to use the system and generate results. In order to consider a CPOE system implementation project as successful, it requires the technology to work on time and within budget, together with users changing their behaviours and effectively using the new system to its full potential.

Because implementing a CPOE system is a complex task that causes a fundamental change, healthcare organizations need to plan carefully before proceeding with CPOE

implementation in order to embrace end-users and mitigate issues that can trigger end-user resistance such as [5], [16], [17]:

- Fear of technology failure, workflow disruption, and autonomy decrease.
- Poor change management practice, such as failing to involve and train users.
- Low administration involvement.
- Insufficient evidence on the return on investment of the CPOE systems.
- Inconsistent data from clinical trials on the added value of the CPOE systems.

The people side is as important as the technical side when implementing the CPOE system; if not, in some cases, more important. Installing the best CPOE system is meaningless if the intended end-users do not accept it. A critical factor that can significantly influence the success of the CPOE implementation is a healthcare organization ability to encourage people to adapt to the new environment and realize the functionalities of the CPOE system and improve healthcare quality and financial performance [18]. Resistance to change is one of the major issues healthcare organizations can face when implementing CPOE systems. People are coming from different backgrounds with different skills, experiences, and levels of comfort with change. Preparing people for the change by addressing their fears and resistance causes will help accelerate the change process and reach expected benefits faster. In summary, a CPOE system implementation needs a change management approach to achieve users' acceptance of the system. The Canadian Change Management Network members define the change management approach of HIT as:

"*…a strategic and systematic approach that supports people and their organizations in the successful transition and adoption of electronic health solutions. The outcomes of effective change management activities include solution adoption by users and the realization of benefits.*" [19].

According to Upperman et al. [20], the implementation of a CPOE system is not just about the technology; it is more about managing people during the change and preparing them with the required skills to engage them in the process and change their behaviours. Hence, the involvement of all potential users during the change planning phase is an important step to accelerate their acceptance of the system. To reach the desired CPOE

implementation success level, end-users must be the center of focus of any proposed change management plan.

User-centeredness has been introduced to computerized systems through *User-Centered Design* (UCD) approaches in order to understand user requirements and needs. UCD is a framework of processes that puts end-users' needs, wants, and constraints first in order to develop a usable system [21]. The introduction of UCD leads to more effective and efficient systems, which in turn results in improved users' acceptance of the developed systems.

Typically, the UCD approach is used to design and develop software systems. However, based on the above knowledge and the conducted literature search, user-centered change management is also essential for the success of the CPOE system implementation. Consequently, the combination of change management and the UCD approach can be used to create a suitable change management plan that potentially makes a significant difference in the success of a CPOE system's implementation.

1.2. Problem Statement

The primary focus of organizations during the CPOE system implementation is usually on technology rather than on users. Many user adoption issues are often a result of ineffective change management [19].

There is a noticeable lack of implementation guidance for CPOE systems. Healthcare organizations need a step-by-step CPOE change management guidance (a roadmap) that considers the needs and limitations of end-users in order to gain their acceptance of the system and allow them to realize its maximum benefits.

The literature includes many articles that emphasize the importance of involving users, physicians in particular, during every step of the CPOE implementation and how this involvement is necessary for the implementation success. However, most, if not all the articles, are considering users' participation during the *design* phase of the system and not during the *change management plan development*. Even if user involvement during the change is mentioned, there is no exact way to attain this involvement, and the principles that govern this involvement remain imprecise and difficult to operationalize.

1.3. Research Objectives

The main objective of this research is to investigate the possibility of integrating UCD principles with change management to improve clinicians' acceptance of CPOE systems by introducing a new User-Centered Change Management (UCCM) process. This process provides a detailed plan for managing change when introducing the CPOE system while focusing on clinicians' needs and requirements. Creating such a plan is expected to develop an appropriate environment for healthcare organizations to successfully implement the CPOE systems and achieve a meaningful transition and use of the implemented systems. The specific objectives of this research are to (a) identify and describe factors that affect users' acceptance of CPOE systems, and (b) develop a change management plan that is user oriented.

1.4. Research Assumptions

There are several important assumptions made in this thesis:

- The CPOE technology/software that is implemented works and generally fits the purpose of the organization.
- The focus of the implementation is on the clinicians and not the patients because clinicians are the system's primary users. Patients are only receivers of the care resulting from using the CPOE system.
- The benefits of a CPOE system cannot be realized unless the latter is fully utilized by clinicians.
- Clinicians' resistance to accept the CPOE system increases risks to patients and increases financial costs as well to both patients and healthcare organizations.

1.5. Definitions

Before diving into the rest of the thesis, several basic terms are first defined and clarified in this section.

CPOE users

A CPOE system is an extensive, complex system with a large number of functionalities. The system users include information technology personnel, administrators, clinicians (including physicians, nurses, and pharmacists), and other allied health professionals (such as dental hygienists, medical sonographers, dietitians, and medical technologists). Because clinicians are the main category of users whose routine will be tremendously affected by the introduction of CPOE, the research will focus on them. In the rest of the thesis, the terms *clinicians* and *users* will be used interchangeably.

Users' acceptance

This research focuses on improving clinicians' acceptance of the CPOE system. For the proposed process purpose, I used the definition of users' acceptance from Dillon and Morris [22]. i.e., "the demonstrable willingness within a user group to employ information technology for the tasks it is designed to support." In other words, the user's acceptance is the user agreement to utilize the system functions and achieve its intended outcomes.

Users' engagement

For users' engagement, I adopted the definition of Cresswell et al. [23]: "… we characterize the concept of engagement as a process by which different organizational groups actively become involved in and contribute to the implementation and successful adoption of HIT". In the proposed process, users' engagement involves user characteristics, requirements, preferences, input, and feedback in the decision-making aspects of the CPOE implementation change management plan.

Users' requirements

In this research, users' requirements refer to the expression of users' needs in terms of training and communication they receive. These users' requirements must not be confused with requirements related to CPOE systems or their features.

CPOE system implementation

According to the Oxford Learner's Dictionary of Academic English [24], implementation is defined as "the act of making something that has been officially decided start to happen or be used." In this research, implementation refers to the process of configuring the CPOE

system and integrating it inside the organization and its processes. This is not to be confused with the design and coding of the CPOE system itself.

1.6. Research Questions

In order to meet the research objectives, this thesis investigates and answers the following research questions:

- **RQ1:** *What are the key activities/factors that influence clinical users' acceptance of the CPOE systems?*

Users' acceptance of the CPOE system is a major indicator of the success of the system implementation. During the introduction of the CPOE system, users go through a substantial change to their work routine. Consequently, they face many factors that could either hinder or facilitate their acceptance of the system. Identifying those factors is essential for decision-makers to plan for the CPOE implementation effectively. It is also the first step in considering the users' needs when planning for the change.

- **RQ2:** *What is the relationship between the acceptance factors and existing change management strategies?*

According to the literature, many of the CPOE system acceptance issues resulted from the change management approach that was used. That could indicate a relation between the factors that affect users' acceptance of the system and the change management strategies.

- **RQ3:** *To what extent does the integration of UCD principles with change management improve clinical users' acceptance of the CPOE systems?*

Assuming that developing a user-centered change management plan is a good way to involve users in the CPOE implementation process and increase their acceptance of the system, I propose to integrate the UCD principles with change management to improve clinical users' acceptance of the CPOE systems. The result of the integration is a user-centered change management (UCCM) process.

1.7. Research Methodology

The implementation of the CPOE system involves a confluence of people (clinicians), organizations (healthcare organizations), and technology (CPOE system). This research aims to improve the effectiveness and utility of the CPOE system by developing a change management plan that considers clinicians as the center of attention to enhance their acceptance of the new system. In this context, the Design Science Research Methodology (DSRM) of Hevner et al. [25], which seeks to extend the boundaries of human and organizational capabilities by creating new and innovative artifacts to solve organizational problems, is an appropriate methodology for this research. Figure 1 presents the DSRM framework.

By definition, design science is basically a problem-solving process. For the resulting solution to be built and appropriately evaluated, seven DSRM guidelines, summarized in Table 1, should be followed.

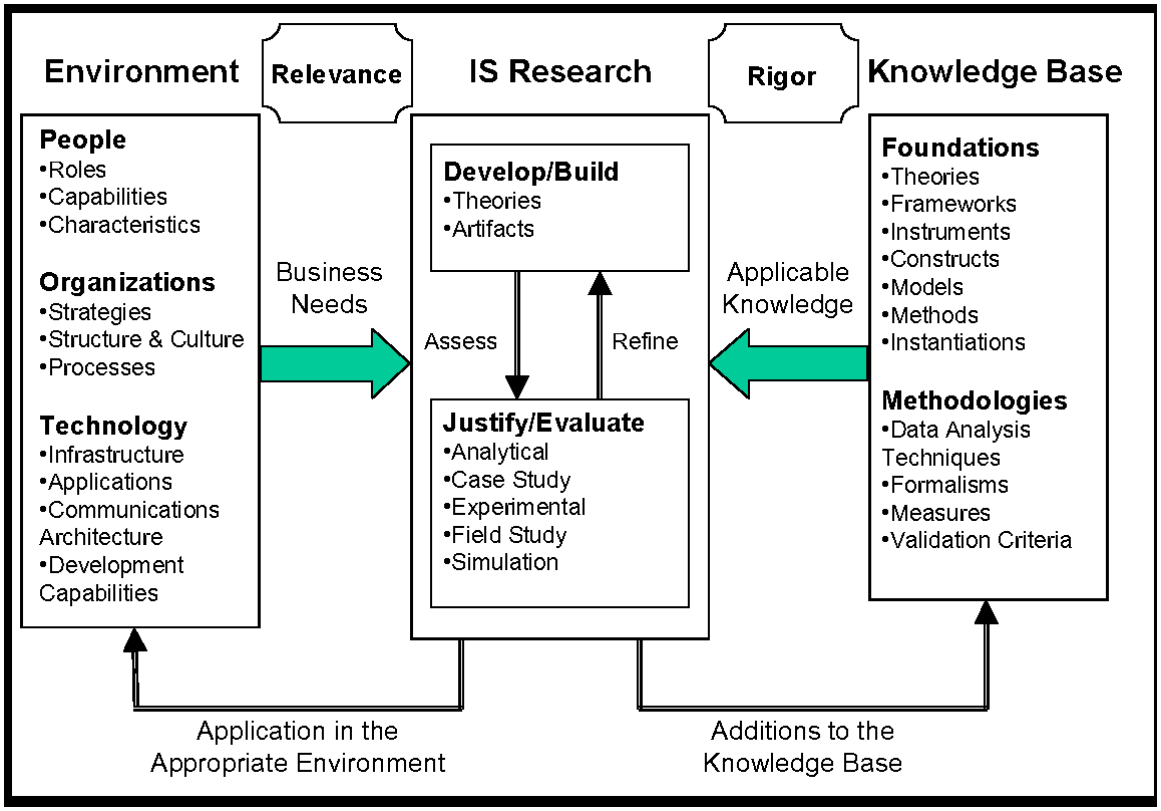

Figure 1 DSRM. Source [25]

Table 1 Seven Design Science Research guidelines. Source [25]

Guideline	Description
Guideline 1: Design as an Artifact	Design-science research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation.
Guideline 2: Problem Relevance	The objective of design-science research is to develop technology-based solutions to important and relevant business problems.
Guideline 3: Design Evaluation	The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods.
Guideline 4: Research Contributions	Effective design-science research must provide clear and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies.
Guideline 5: Research Rigor	Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact.
Guideline 6: Design as a Search Process	The search for an effective artifact requires utilizing available means to reach desired ends while satisfying laws in the problem environment.
Guideline 7: Communication of Research	Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences.

To conduct this research and answer the thesis research questions, the above DSRM guidelines are used as follows:

1. **Design as an artifact:** Healthcare organizations are in need of step-by-step guidance on how to develop a change management plan for the CPOE implementation while considering the needs and limitations of end-users in order to gain their acceptance of the system and to realize its maximum benefits. In this context, this thesis's main artifact is a process, namely *User-Centered Change Management* (UCCM). *Chapter 4* presents the design of the UCCM process.
2. **Problem relevance:** During this step, previous solutions that either used change management theories or UCD approaches have been studied carefully to assess the gap between what is available and what is needed, and to understand how to fill

that gap. In addition, this step helps identify facilitators and barriers to the CPOE users' acceptance by reviewing the related literature. *Chapter 2* and *Chapter 3* examine basic background and the literature on the problem investigated in this thesis.

3. **Design evaluation:** The evaluation of the UCCM process is done in three steps. First, in *Chapter 5*, the UCCM process coverage of the change management and UCD principles is assessed. Moreover, the UCCM process consideration of the factors that affect users' acceptance of the CPOE system is also evaluated. The second step, also presented in *Chapter 5*, validates the UCCM process and surveys with key healthcare informants and against other healthcare guidelines on change management. Finally, in *Chapter 6*, the UCCM process is evaluated using a retrospective case study involving a hospital in British Columbia, Canada.
4. **Research contributions:** The significance and impact of the UCCM process on clinicians and healthcare organizations are discussed in *Chapter 7*, together with limitations and threats to validity.
5. **Research rigor:** The research starts with a systemized literature review (based on the approach of Kitchenham [26]) to help ensure extensive coverage of previous work (*Chapter 3*), and it ends with retrospective case study (*Chapter 6*) to evaluate the usefulness of the proposed UCCM process. In order to identify user requirements, a *descriptive research (cross-sectional)* survey is introduced in the form of a questionnaire (available in both English and French in *Appendix A*). For the evaluation process, an *evaluation research* survey, also in the form of a questionnaire, is introduced (*Appendix B*).
6. **Design as a search process:** The UCCM process is validated against barriers and recommendations that have been derived from relevant literature. In addition, the UCCM process was presented to key health informants and then updated based on their feedback and comments. A second iteration helped further improve the survey based on feedback from key health informants.
7. **Communication of research:** In addition to this thesis, several papers related to this work are listed in *Section 1.9*.

Based on the DSR knowledge contribution framework [27], the main contribution of this research belongs to the improvement quadrant. The next section presents the thesis contributions.

1.8. Thesis Contributions

This thesis offers one major contribution (related to prescriptive knowledge in DSR terms) and one minor contribution (related to descriptive knowledge):

- **Major Contribution**

  A user-centered change management (UCCM) process that helps healthcare organizations implement their CPOE system by planning and managing the change accompanying such implementation. The UCCM process includes:

  - A process that combines UCD and change management approaches.
  - A customizable guide that can be adjusted to meet the needs of different users, organizations, and clinical settings.
  - A systematic change process that makes users the center of the change.
  - Survey examples that can help:
    a. Collect user requirements to improve their acceptance of the CPOE system. The survey is available in English and French (*Appendix A*). It was deployed as a pilot in Hospital A. *Appendix D* presents the survey's results.
    b. Measure users' satisfaction with the change management plan, after the CPOE implementation (*Appendix B*).

- **Minor Contribution**
  - A list of factors that can affect users' acceptance of the CPOE system.

The UCCM process represents particularly novel knowledge as the first user-centered change management process, even outside of healthcare.

1.9. Publications

The following paper is based on this thesis' Chapter 3:

- **Almoaber, B.** and Amyot, D.: Key Factors of Clinicians' Acceptance of CPOE System and their Link to Change Management. Submitted to *Informatics for Health and Social Care* (accepted with minor changes, February 15, 2021).

The following conference papers (with M. Baslyman as the main author) provide the details of one of the proposed techniques used in the UCCM process to analyze context and work-flows in a healthcare process change management context:

- Baslyman, M., **Almoaber, B.**, Amyot, D., and Bouattane E.M.: Activity-based Process Integration in Healthcare with the User Requirements Notation. In: *E-Technologies: Embracing the Internet of Things (MCETECH 2017)*, Ottawa, Canada. Lecture Notes in Business Information Processing, vol. 289, pp. 151–169, 2017.
- Baslyman, M., **Almoaber, B.**, Amyot, D., and Bouattane E.M. Using Goals and Indicators for Activity-based Process Integration in Healthcare. In: *7th Int. Conf. on Current and Future Trends of Information and Communication Technologies in Healthcare (ICTH 2017)*, Lund, Sweden. Procedia Computer Science, vol. 113, pp. 318–325, 2017.

In collaboration with The Ottawa Hospital (where I had an internship during my doctoral studies), I was involved in another project related to change management in healthcare, where some of the UCCM ideas were developed and used. This work was also submitted to a journal:

- **Almoaber, B.,** Liska, C., and Morash, R.: Cancer Survivorship Care Program: A Case Study in Business Process Management and Change Management in Healthcare. Submitted to *International Journal of Healthcare Information Systems and Informatics (IJHISI)* on July 08, 2020.

The final content of this thesis was also influenced by two early literature reviews on healthcare information technologies (HIT) and emergency department processes, which helped me scope my work to the change management process for one particular type of HIT, namely CPOE. Both journal papers were also recently selected by the publisher as book chapters:

- **Almoaber, B.** and Amyot, D.: Barriers to Successful Health Information Exchange Systems in Canada and the USA - A Systematic Review. *Int. J. of Healthcare Information Systems and Informatics*, 12(1), 44-63, 2017.
- **Almoaber, B.** and Amyot, D.: Barriers to successful health information exchange systems in Canada and the USA: a systematic review. M. Khosrow-Pour (Ed.) *Virtual and Mobile Healthcare: Breakthroughs in Research and Practice*, Chapter 15, IGI Global, 328-350, 2020
- **Almoaber, B.** and Amyot, D.: A Review on the Contribution of Emergency Department Simulation Studies in Reducing Wait Time. *Int. J. of E-Health and Medical Communications*, 8(3), 1-21, 2017.
- **Almoaber, B.** and Amyot, D.: A Review on the Contribution of Emergency Department Simulation Studies in Reducing Wait Time. M. Khosrow-Pour (Ed.) *Hospital Management and Emergency Medicine: Breakthroughs in Research and Practice*, Chapter 30, IGI-Global, 599-623, 2020.

1.10. Thesis Outline

The remainder of the thesis is structured as follows:

- **Chapter 2:** Presents background on the main concepts considered in this research, such as CPOE, user acceptance of HIT, change management, and UCD.
- **Chapter 3:** Presents a three-part literature review on the factors that affect users' acceptance of CPOE systems, the use of change management theories during CPOE implementation, and the current use of UCD during the implementation of CPOE systems.
- **Chapter 4:** Introduces the UCCM process. The chapter describes the basics concepts and components of the UCCM process. It also explains each step's goals, input, and output, as well as how users are involved in each step of the process.
- **Chapter 5:** Assesses the UCCM process coverage of the change management and UCD principles and its coverage of the clinicians' acceptance factors that have been identified in Chapter 3. It also validates the UCCM process and surveys with key

healthcare informants and against other healthcare guidelines on change management.

- **Chapter 6:** Presents the retrospective case study: Island Health's IHealth Electronic Health Record System.
- **Chapter 7:** Discusses the significance of this study and its expected impact on healthcare. It also considers the most closely related work and how it differs from this study. Lastly, it concludes by presenting challenges, limitations, and threats to the validity of this thesis.
- **Chapter 8:** Concludes the thesis, summarizes contributions of the research, answers the research questions, and discusses future work.

Chapter 2. Background

This chapter gives a broad overview of the central concepts considered in this research. The first part of this chapter gives an introduction to Computerized Provider Order Entry (CPOE) systems, including their related functions, as well as benefits and controversies around their usage. The second part of this chapter focuses on user acceptance of Health Information Technology (HIT). It starts by presenting known technology acceptance theories and reviews how those theories are used in HIT. The third part analyzes some of the most common change management models. The chapter concludes by reviewing the user-centered design (UCD) approach and its main components, and by highlighting how UCD is used in the healthcare context.

2.1. Computerized Provider Order Entry

Increasingly, reports from Canada and the USA show that a significant number of patients experience adverse events (medical errors) such as getting the wrong medication, developing an infection and other medical accidents. In 1999, the Institute of Medicine reported that between 44,000 and 98,000 deaths annually were due to medical errors [28]. In a 2016 report from Makary and Daniel [29], medical errors have been reported as the third leading cause of death in the USA, following heart diseases and cancer. On the Canadian side, the Canadian Institute for Health Information (CIHI) and the Canadian Patient Safety Institute [30] reported that 138,000 patients, one in every 18 patients, were admitted to a Canadian hospital in 2014-2015 suffered from adverse events. While the above reports considered medical errors in general, other reports focused more on medication errors or adverse drug events. A Canadian study by Baker et al. reported that medication errors were the second most common type of adverse event after surgical errors [31]. Shehab et al. [32] have reported that in 2013-2014, four in 1000 emergency room visits in the USA occur because of adverse drug events.

Medical errors are not only costly, but they are also harmful and can potentially cause severe illness and even death. According to Forster et al. [33], adverse drug events often occur during the ordering and administration stages of medication delivery.

Moreover, healthcare providers are faced with a vast amount of new care methods and many decisions regarding therapies, drug interactions, drug names and effects. This means that there is a need for a technology that can help connect healthcare providers with the information they need at the point of care delivery to help them make informed decisions.

Many studies have established that *Health Information Technology* (HIT) or simply *health IT* is a promising tool that will help mitigate medical errors, improve healthcare quality, safety and efficiency, lower costs, and enhance patient experience [3]. In particular, *Computerized Provider (or Physician/Prescriber/Practitioner) Order Entry* (CPOE) systems are one of the recommended supportive technologies aiming to reduce medical errors as well as to improve safety, quality, and value of patient care.

2.1.1 CPOE Definition

CPOE is a software application used by clinicians to digitally enter diagnostic and therapeutic orders and then electronically transmit them to the appropriate departments or services for execution. CPOE is usually equipped with a *Clinical Decision Support System* (CDSS) to support clinicians and improve quality and safety by reducing errors at various stages during the order-entry process.

CPOE systems can be standalone systems with their own functions or be integrated into existing systems such as *Electronic Medical Records* (EMRs). CPOE systems are often implemented as part of an overall transition from paper-based records to a complete EMR.

For a more refined division, CPOE systems can also be specialized to an application area such as hospitals, ambulatory centers, physicians' offices, and emergency health services [34]. With CPOE, clinicians have the ability to enter medication orders from computer terminals or mobile devices from any location in the health system.

Figure 2 and Figure 3 illustrate two screens of a CPOE portal. Portals vary from one vendor to another and from one department to another. Figure 2 shows an example of

active orders display on the electronic Medication Administration Record (MAR). Figure 3 presents system alerts through an example of an acetaminophen overdose.

Another CPOE system portal example is shown in Figure 4 and Figure 5 that illustrate two typical screens of a CPOE system portal. Figure 4 is a drug prescribing page, while on the right side of the screen, a list of the patient's current medications is presented. Figure 5 shows a similar example of blood work order entering and the list of the patient's previous orders.

The CPOE systems market is proliferating. A recent market research report by Ameco Research identifies Cerner, CliniComp, Allscripts, Epic Systems, GE Healthcare, McKesson, Siemens Healthcare, Visual MED, Philips Healthcare, and Athena Health as the key players of that market [34].

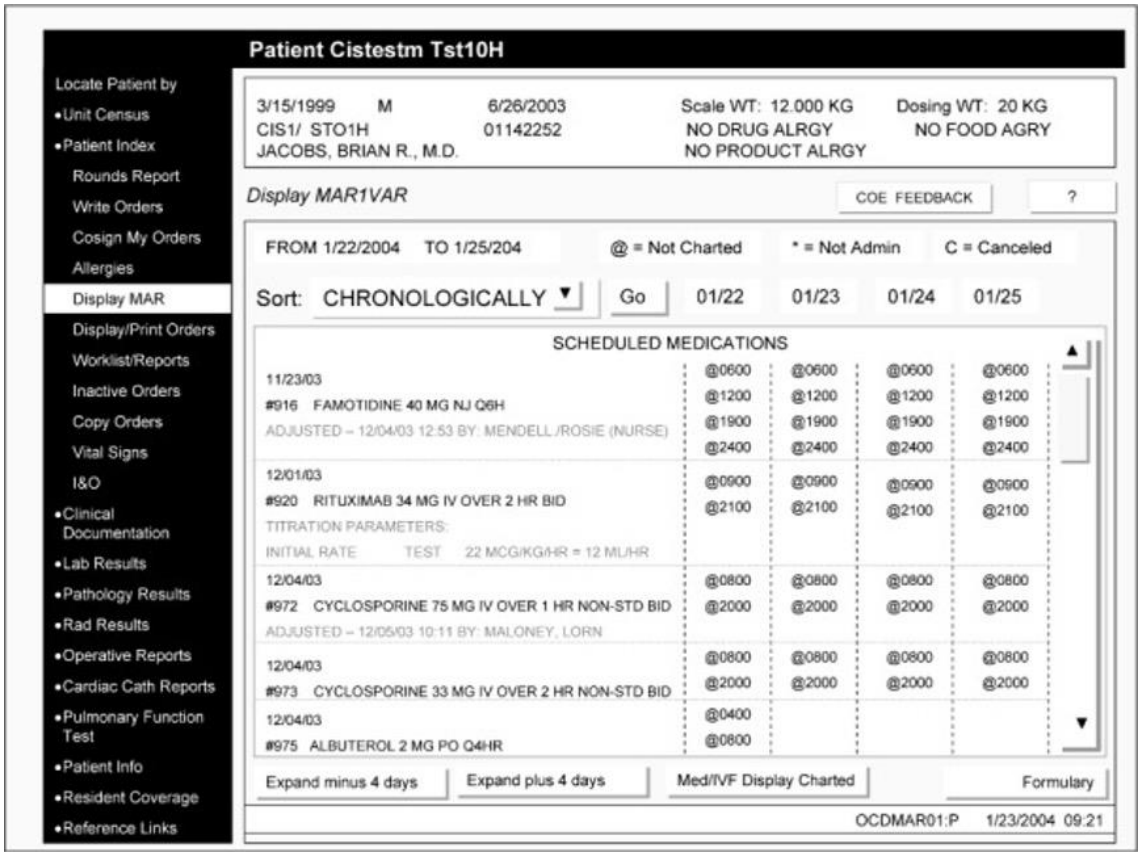

Figure 2 A CPOE portal screenshot (1). Source [35]

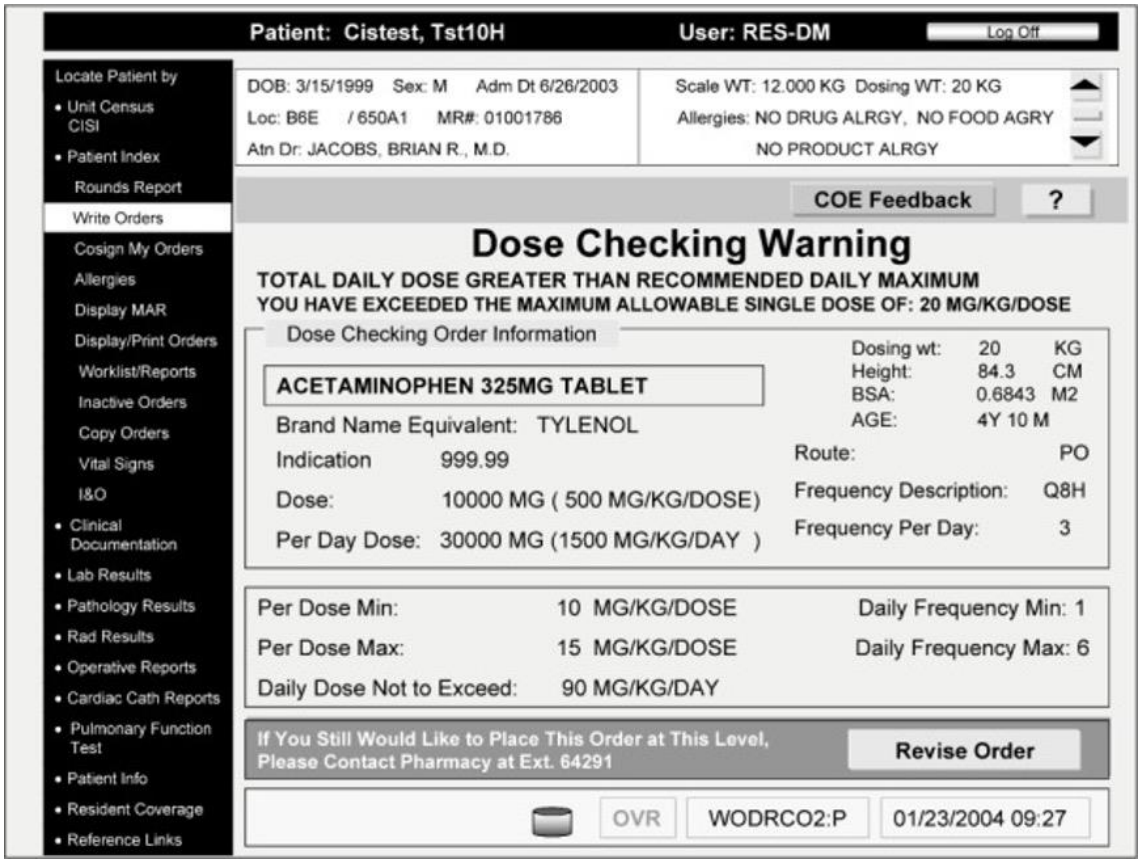

Figure 3 A CPOE portal screenshot (2). Source [35]

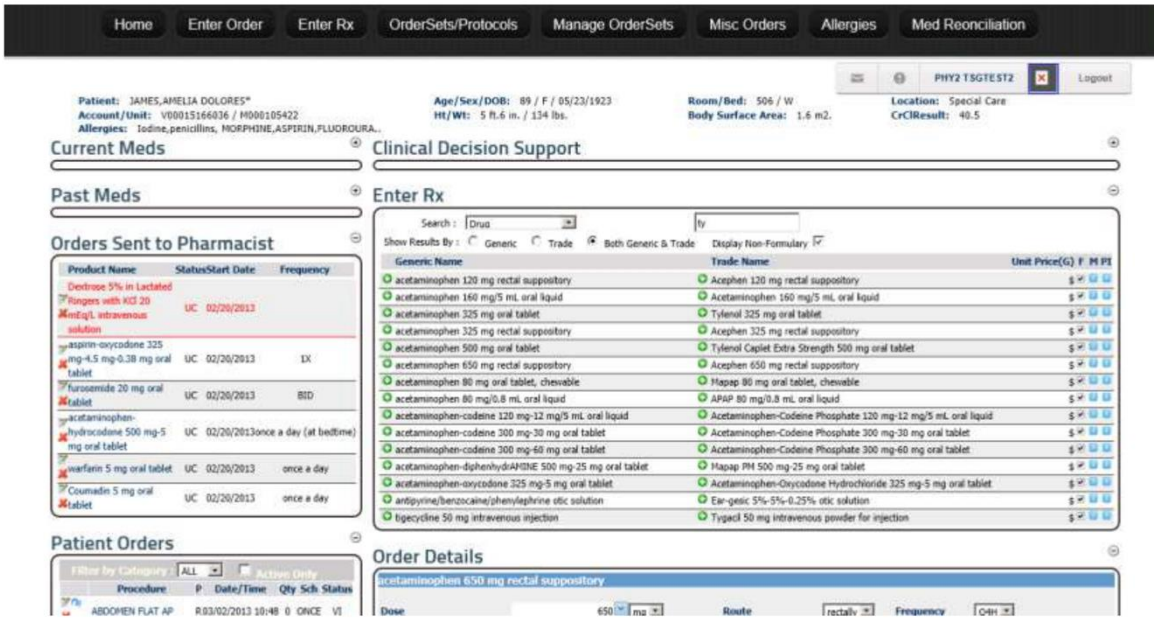

Figure 4 A CPOE portal screenshot (1). Source: https://shamsgroup.com/wp-content/uploads/2016/02/Product_Presentation_PhysicianProviderPortal_CPOE.pdf

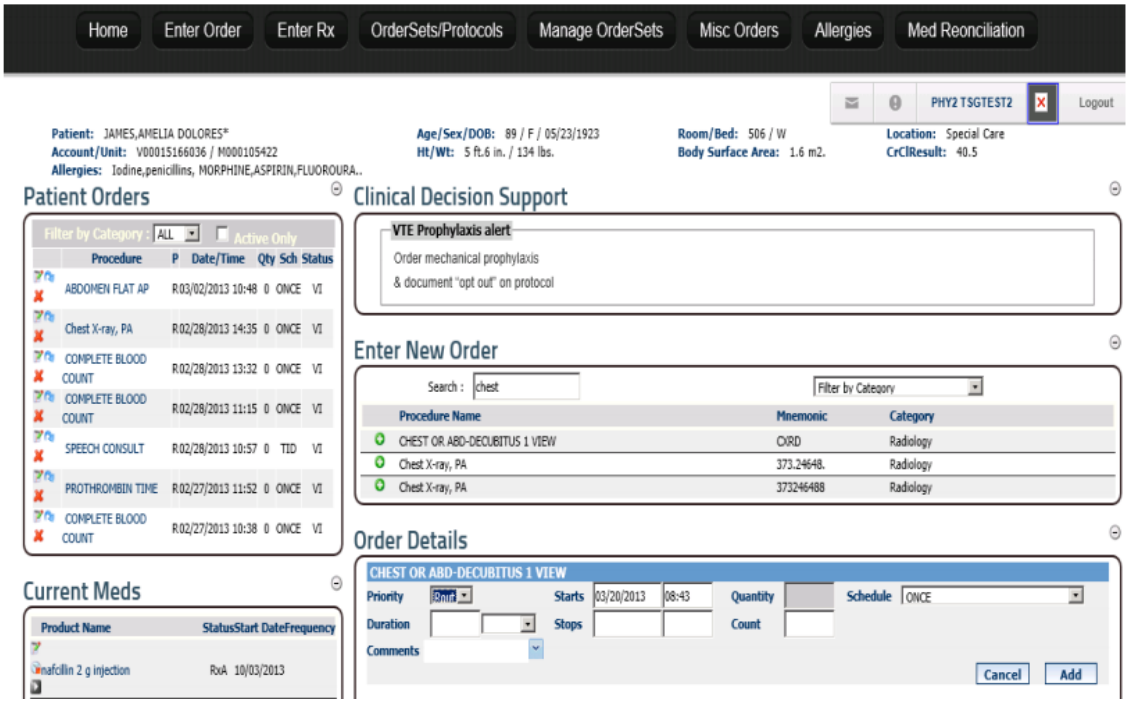

Figure 5 A CPOE portal screenshot (2). Source: https://shamsgroup.com/wp-content/uploads/2016/02/Product_Presentation_PhysicianProviderPortal_CPOE.pdf

2.1.2 CPOE Order Sets

As the CPOE name indicates, the prime function of the CPOE system is the entrance and transmission of orders between departments. A CPOE *order* is a clinical request or instruction involving typically laboratory tests, medications, or treatments. Because the ordering process can be time-consuming, orders can be grouped into order sets. *Order sets* are collections of orders grouped according to a clinical purpose. Each CPOE system configures hundreds of orders and order sets so users can fill and read them quickly, and so the system can check their validity.

Besides their role in standardizing the ordering process, order sets can reduce the amount of time physicians need to enter orders by allowing them to choose from a menu. In addition, order sets can encourage evidence-based care, improving care efficiency and decision support [36].

2.1.3 CPOE with CDSS

The incorporation of CPOE with CDSS offers support that usually includes, but not limited to, checking for required fields, offering a list of default orders or order sets, and dosing calculation taking into account patient characteristics, recent test results, and knowledge-based rules [7]–[9], which in results adds more benefits to the medication prescribing process.

CPOE with CDSS functions, such as drug-drug interaction checking and clinical guideline recommendations, assist healthcare providers in moving from expert opinion-based to evidence-based clinical decision-making by reducing the factors that are most commonly associated with prescription errors [37]:

- Knowledge and appreciation of drug therapy factors;
- Consideration of patient factors that affect drug therapy;
- Calculations, decimal points, or unit and rate expression factors; and
- Medication dosage form and Nomenclature-related problems.

These CDSS functions are typically implemented using system alerts, system defaults, or order templates.

2.1.4 CPOE Benefits

The benefits of CPOE systems go beyond allowing clinicians to enter orders directly into a computer rather than handwriting them. A CPOE system introduces clinical decision support into daily practice to provide dosing guidance, reduce errors, and increase quality. Furthermore, CPOE facilitates the standardization of healthcare practices, improves communication between different departments, accelerates patient transfers, and provides a platform to collect data for research, management, and monitoring [7]–[9].

Generally, the CPOE system benefits can be divided into three categories; benefits to patients care, benefits to healthcare organizations, and benefits to healthcare providers.

CPOE benefits to patient's care

A CPOE system enhances patient safety and improves patients care quality by:

- **Reducing or eliminating medication errors:** A CPOE system provides safeguards that help providers check for potential adverse drug events.

- **Providing better care:** with a CPOE system, healthcare providers have access to up-to-date patient information, including complete medical history, which helps them make informed decisions and provide better care.
- **Improving patient safety:** A CPOE system includes many safety features such as real-time patient identification, patient's allergies, medication dosage recommendations, and adverse drug-to-drug interactions.

CPOE benefits to healthcare organizations

CPOE system benefits to healthcare organizations include:

- Reducing response time between departments;
- Improving resource utilization;
- Lowering costs;
- Standardizing practice through the development of order sets;
- Improving interdepartmental communication;
- Capturing data for management, research, and quality monitoring;
- Complying with regulations;
- Improving documentation, including referral and treatment preapprovals; and
- Improving insurance management.

CPOE benefits to healthcare providers

A CPOE system provides many benefits to providers, such as:

- **Incorporating clinical decision support into daily practice:** Incorporating CDSS with the CPOE system helps providers make informed decisions regarding patients care through real-time decision support.
- **Improving the ordering process:** Healthcare providers can enter orders using computers or other devices securely. This leads to clarity of orders and accuracy in identifying the order provider.
- **Improving information access:** Unlike paper charts, a CPOE system allows providers to access and manage patient charts remotely. With a CPOE system, patient charts are always available at any computer or workstation. Providers do not have to search for a paper chart.

- **Improving ordering efficiency:** A CPOE system allows healthcare providers to transmit orders electronically and quickly to the relevant departments.

2.1.5 CPOE Controversies

Despite the many reported benefits of CPOE systems to the healthcare process, these systems have been criticized for many issues. Researchers reported that CPOE systems had created new types of medication errors [38], such as selecting the wrong drug from drop-down menus [39]. A large number of unnecessary medication alerts can also cause alert fatigue [39], [40].

Vélez-Díaz-Pallarés et al., in their recent systematic review of computerized prescriber order entry and clinical decision support [39], have reported that CPOE implementation did not lead to reductions in allergy errors. That is possibly due to inadequate training and/or incorrect completion of related allergy records. Most of the reported issues with that CPOE system were related to its design and usability.

Additionally, in comparison to conventional paper-based systems, CPOE systems require more up-front time from health service providers to complete some workflows [41].

2.2. User Acceptance of HIT

Information technologies have been introduced to the healthcare field to transform the healthcare industry and overcome some of the challenges related to information management. For example, physicians and other caregivers rely on paper-based records keeping. However, medical care has advanced, and many specialists and information sources have been needed to provide necessary care. This advancement in healthcare caused several problems, including the lack of systematized information sharing and care coordination, duplicative patient testing, and adverse drug events [42], [43].

Health information technology (HIT), such as electronic health record systems (EHR) or CPOE, can advance healthcare further and solve some of its issues. Such systems provide a complete patient health record at the point of care and can be reached from multiple locations. Additionally, system data can be used to improve care processes and

protocols. Furthermore, HIT promotes evidence-based practices by providing clinical decision-support tools at the point of care [42].

Even though HIT is key to improving efficiency and quality of healthcare [44], many HIT projects were rejected or underused by intended users.

User acceptance is essential because resisting HITs will underutilize those technologies' functions and cause a negative return on investment [45]. In other cases, lack of stakeholder buy-in can hinder the implementation of most needed systems such as health information exchange systems [46]. A large number of studies adopted well-known (information) technology acceptance theories to examine critical factors underlying user acceptance of HITs. This section defines technology acceptance along with a brief description of three famous technology acceptance models and their use and limitations in a HIT context.

2.2.1 Technology/User Acceptance

Before diving into the different technology acceptance theories, it is helpful to define what technology acceptance means. According to Davis et al. [47], *technology acceptance* (or user acceptance) is the individual's intentional or voluntary use of technology.

Information technology (IT) acceptance and user satisfaction with IT systems are often mixed up. IT *acceptance* focuses on usage intentions and behaviour. In contrast, user *satisfaction* focuses more on users' feelings toward the system. Al-Gahtani and King [48] described user satisfaction as "the affective reactions of individuals toward the usage of computer applications in general". User attitudes, usage, and satisfaction are significant indicators of user acceptance of IT [48].

IT acceptance is necessary because a lack of acceptance impedes the success of information systems. It is common in information systems research to use user acceptance as a determinant of an IT product's success or failure [47], [48].

2.2.2 Technology Acceptance Theories

Ensuring user acceptance of technology is an ongoing management challenge that has been extensively explored, resulting in multiple prediction models and theories. This section

provides a brief review of three of the most widely recognized models. Table 2 summarizes definitions of the constructs that are shown in the reviewed models.

Technology Acceptance Model (TAM)

TAM, introduced by Davis [49], is adopted from the Theory of Planned Behavior [50]. The model was introduced to explain why people would accept or reject the use of technology in the work context. TAM's fundamental purpose is to uncover the impact of external factors on individuals' beliefs, attitudes, and intentions [47]. According to TAM, the system's actual use is affected by an individual's intention that is influenced by an individual's attitude, which in turn is determined by two key measures: perceived ease of use and perceived usefulness (Figure 6). If the user perceives the introduced technology as useful and easy to use, s/he will have a positive attitude towards technology and be more likely to use it.

TAM development advanced through three stages: adoption, validation, and extension. In the adoption phase, TAM was adopted through several information system applications. In the validation phase, TAM usage was tested with different technologies. In the third phase, the extension, TAM was extended to include other variables [51].

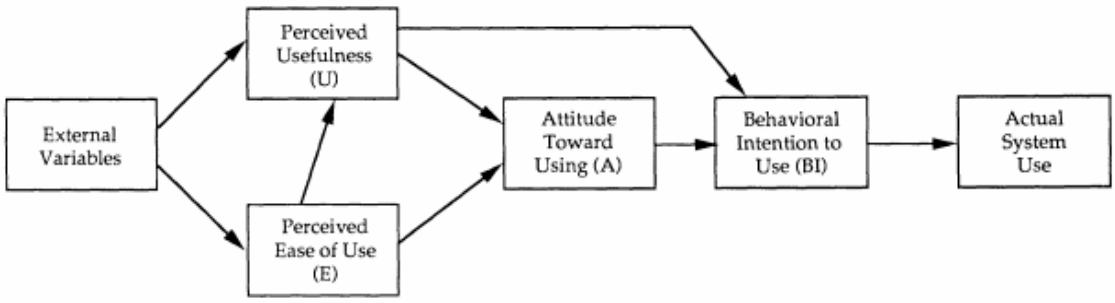

Figure 6 Technology Acceptance Model (TAM). Source [47]

Extended Technology Acceptance Model (TAM2)

In the original TAM, perceived ease of use and perceived usefulness are the key constructs that are critical to examining the acceptance of an information system [49]. However, additional research recognized the importance of social influence and cognitive instrumental processes on the system's actual use. Hence, the original TAM model has been extended to TAM2 by including social influence and cognitive instrumental processes to capture

their effect on both perceived usefulness and behavioural intention [52] (Figure 7). The social influence process includes subjective norm, voluntariness, and image. The four cognitive instrumental determinants of perceived usefulness are job relevance, output quality, result demonstrability, and perceived ease of use.

According to TAM2, efficiency in understanding user adoption behaviour was tested using longitudinal data collected regarding four different systems in four organizations and shows better results in comparison to the original TAM.

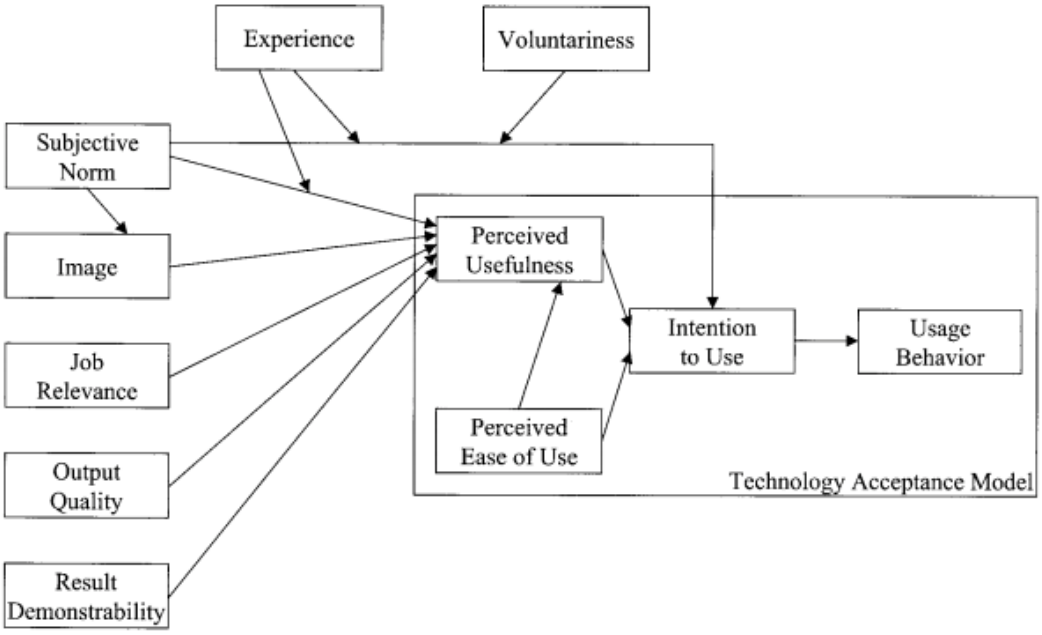

Figure 7 Extended Technology Acceptance Model (TAM2). Source [52]

Unified Theory of Acceptance and Use of Technology (UTAUT)

Another update on previous work on the field of information technology acceptance led to the development of UTAUT. Venkatesh et al. [53] examined eight models, namely TAM, theory of reasoned action (TRA), theory of planned behaviour (TPB), the Motivational Model, the Model of PC Utilization, a combined TPB/TAM, Social Cognitive Theory (SCT), and Innovation Diffusion Theory (IDT), on individual acceptance and use of technology. By empirically comparing those eight models for four different IT systems in four different industries, including two voluntary and two mandatory systems, UTAUT was developed to assess an individual's intention to use a specific system or technology. UTAUT (Figure 8) consists of four core constructs and four moderators. The four core constructs

(performance expectancy, effort expectancy, social influence and facilitating conditions) directly affect an individual's behavioural intention. Nevertheless, these core constructs are moderated by gender, age, experience, and voluntariness of use [53].

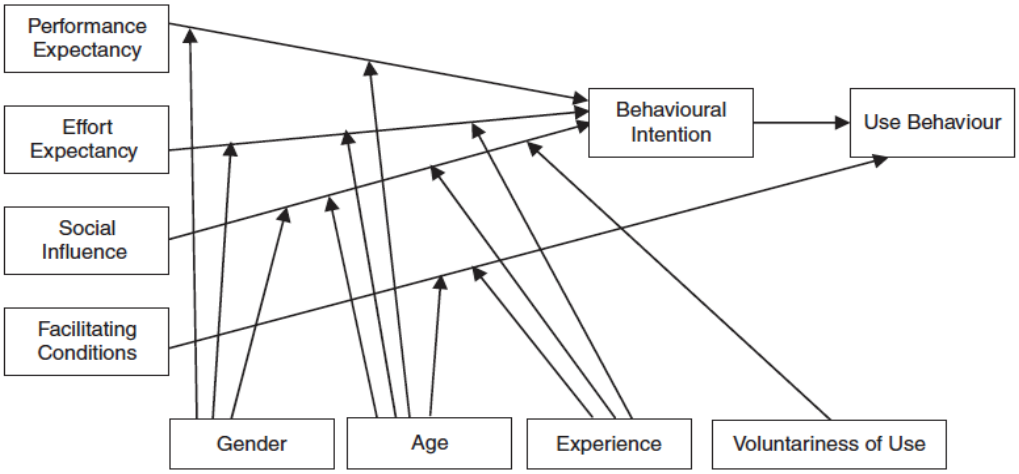

Figure 8 Unified Theory of Acceptance and Use of Technology (UTAU). Source [53]

Table 2 Technology acceptance models constructs definitions

Construct	Definition	Model		
		TAM	TAM2	UTAUT
External variables	External factors that determine an individual's attitude towards the system [47]	√		
Perceived usefulness / Performance expectancy	"The prospective user's subjective probability that using a specific application system will increase his or her job performance within an organizational context." [47], [52], [53]	√	√	√
Perceived ease of use / Effort expectancy	"The degree to which the prospective user expects the target system to be free of effort." [47], [52], [53]	√	√	√
Actual usage behaviour	Actual technology use behaviour in the context of technology acceptance [47]	√	√	√
Attitude	"An individual's positive or negative feelings (evaluative affect) about performing the target behavior" [47], [54]	√		
Subjective norm / Social influence	"Person's perception that most people who are important to him think he should or should not perform the behavior in question" [52], [53], [54]		√	√
Voluntariness	"The extent to which potential adopters perceive the adoption decision to be non-mandatory" [52], [53], [55]		√	√
Image	"The degree to which use of an innovation is perceived to enhance one's... Status in one's social system." [52], [55]		√	
Job relevance	"An individual's perception regarding the degree to which the target system is applicable to his or her job." [52],		√	
Output quality	How well the system performs its tasks [52]		√	
Result demonstrability	"Tangibility of the results of using the innovation," [52], [55]		√	
Facilitating conditions	"The degree to which an individual believes that an organizational and technical infrastructure exists to support the use of the system" [53]			√
Gender	Measures male and female [53]			√
Age	Measures age by ranges [53]			√
Experience	Measures years of work experience [53]			√

2.2.3 Technology Acceptance Theories in HIT

This research focus is on users' acceptance of the CPOE system. For that reason, this section considers the use of technology acceptance theories in the context of the CPOE system implementation. This section aims to give an example of how these theories have been employed in the context of CPOE systems and their limitations. Multiple studies were done to examine users' acceptance and satisfaction of CPOE systems, such as [56], [57], [58].

Al-nassar et al. [56], conducted quantitative research to examine the post-implementation physicians' usage behaviour of the CPOE system in Jordanian hospitals based on TAM. Their findings indicated that different technical factors, instability of new software providers, and software quality had a significant relationship with perceived ease of use but not with the perceived usefulness. Additionally, a significant relationship was found between perceived usefulness and behavioural intention of using the CPOE system. However, the relationship between perceived ease of use and the behavioural intention was insignificant. Finally, the behavioural intention was significantly related to user adoption of the CPOE system.

In a large Chinese hospital, Liang et al. [59] performed an empirical investigation to validate the use of TAM in explaining physicians' acceptance of the CPOE system. The investigation results showed that TAM could be applied to predict physicians' acceptance of the CPOE system during the development of the system and after it is actual usage. The researchers have found that all relationships predicted by TAM are supported; however, the perceived ease of use failed to affect physicians' attitudes because it is moderated by the physician's experience of the CPOE system.

There is a drought of studies that examine users' acceptance and satisfaction of the CPOE system through technology acceptance theories. However, multiple literature reviews are dedicated to reviewing the use of such theories for the adoption of other HITs, for example, user acceptance of consumer-oriented health information technologies [45], clinicians' adoption of mobile health tools [60], adoption of electronic health record [61], [62], and in health informatics in general [63], [4].

Limitations

Technology acceptance theories have many drawbacks. These theories narrow their focus on adoption or acceptance as affected by individuals' beliefs and attitudes and overlook the

complexity of the socio-technical systems such as HIT [64]. Moreover, these theories assume that people plan their behaviour and that they are always rational in their actions. Additionally, the theories consider many factors that can affect users' acceptance but do not explain how to make technologies useful or easier to use, for example. Technology acceptance theories conceptualize system use as the frequency of using the system, or the time spent using it, rather than value-adding use [64], [65].

In the healthcare context, many studies have concluded that physicians' characteristics are unique and different from other professions [66]. Hence, their characteristics affect information technology adoption differently. They tend to have a pragmatic perception of the adoption of technology [67], [68]. For example, physicians are willing to adopt and use technology if they perceive those technologies as beneficial in helping them perform their jobs efficiently [67]. Their focus is on the usefulness of the technology, rather than the ease of using it. So, perceived ease of use does not significantly affect clinicians' behavioural intentions or perceived usefulness of a technology [67]. Additionally, a couple of studies concluded that physicians value their own assessment more than others when it comes to making the technology acceptance decision. This means that social influence processes have insignificant effects on their intentions [67], [68].

When implementing a CPOE system, the healthcare organization aims towards a successful implementation by insuring users' acceptance of the system and meaningful use of that system. Although it has been inferred from the CPOE literature that usefulness and ease of use of a CPOE system would provide an insight into users' willingness to accept and use the system, however, proper planning for the change associated with the CPOE implementation may have a higher impact on the users' acceptance of the system.

My research goal is to improve users' acceptance of the CPOE system by developing a change management plan that focuses on those users. It is essential to consider the technology acceptance theory constructs when planning for the associated change with the CPOE system. However, relying on those theories alone does not help in developing an efficient change management plan.

2.3. Change Management

In today's world, technological innovations are rapidly revolutionizing the working habits and practices of many organizations. Those innovations are not only changing current workflows but are also creating new expectations about how to integrate people, processes, and technologies quickly and seamlessly for organizations to remain competitive. One key factor for keeping pace with technological innovations disruption is the organization's ability to manage the associated changes effectively.

The introduction of new information technology to any organization initiates changes to the organization's technological and social aspects. Organizations usually face resistance towards change initiatives that may result in users not accepting the new system or any introduced change. Organizations and their managers, in particular, need to find strategies to be able to deal with change challenges and mitigate resistance. Change management theories have been introduced as an effective way to manage change and can be adapted to manage technology-driven change in organizations.

Change management refers to the process of preparing individuals to adopt transformation successfully. When introducing a new IT system, change management aims to prepare users to accept and use the system. Change management focuses on managing the people side of projects to instigate successful transformations from status quo (before the system implementation) to the desired outcome (accepting the new system). Several well-established change management models and theories have been published, such as Kotter's model [69] and Lewin's model [70].

2.3.1 Types of Change

According to AlManei et al. [71], change "is identified as the behavioural shift of the organization as a whole, from one being to another". Change can be classified into many categories based on different perspectives. For example, change can be planned or unplanned. Planned change is a result of deliberate decisions to change the organization, while unplanned change is a result of unforeseen occurrences [72]. Both planned and unplanned changes can be caused by external and internal factors (forces). External forces come from outside the organization such as regulators, competitors, customers, and technology, whereas internal forces for change come from obsolete services and products,

new market opportunities, new strategic directions, and an increasingly diverse workforce [73].

Other possible classifications of change are based on the intended outcome (transformational or small change, i.e., re-adjustment) and on the function of the change process (rapid or incremental) [74]. Furthermore, based on the above classification, change can be characterized as follows (see also Table 3):

- **Evolution:** a large-scale change carried out over a long period of time;
- **Revolution:** a large-scale change carried out in a concise period of time;
- **Adaptation:** a small-scale change carried out gradually; or
- **Reconstruction:** a small-scale change carried out rapidly.

Table 3 Types of change (adapted from [74])

		Outcome	
		Transformation	**Re-adjustment**
Process	**Incremental**	Evolution	Adaptation
	Rapid	Revolution	Reconstruction

Additionally, change can be categorized as *top-down* or *bottom-up* based on who originates it and how it is introduced [71]. The senior levels drive the top-down change while the bottom-up change originates at the lower levels of an organization by practitioners.

2.3.2 Change Management Models

Change management models are used to describe the change process so managers can understand how to apply change principles to their organizations. Since the literature is rich with interesting models that cannot all be covered here, five of the most common models are discussed next.

Lewin's model

Lewin's change management model [70] is a simple model composed of three steps: unfreezing, moving, and refreezing (Figure 9).

1. **Unfreezing:** The first step is to disturb the status quo in order to establish the need for change. This step aims to mitigate employees' resistance to change by bringing awareness about the urgency of the change and communicating change benefits to each employee and the entire organization.
2. **Change:** After convincing employees about the need for change, it is time to move toward the desired status. This step is the hardest one as employees are now beginning to learn the new processes and adapting to new required behaviours. Communication and support are crucial at this stage to remind employees of the reasons for the change and how it will benefit them once fully implemented.
3. **Refreezing:** The last step of Lewin's model is to stabilize and solidify the new status after the change as the new norm. It is crucial to provide the required rewards and acknowledgments to prevent employees from slipping back into old behaviours.

Lewin's model is a very general and easy-to-understand approach that organizations unaccustomed to change management models can apply. However, Lewin's model has been criticized for being too simplistic and rather goal-oriented, and it may lack proper consideration for individuals' feelings and experiences, which in turn can have negative consequences on individuals' acceptance of the change. It does not discuss how to deal with individuals' resistance to change other than motivation and encouragement.

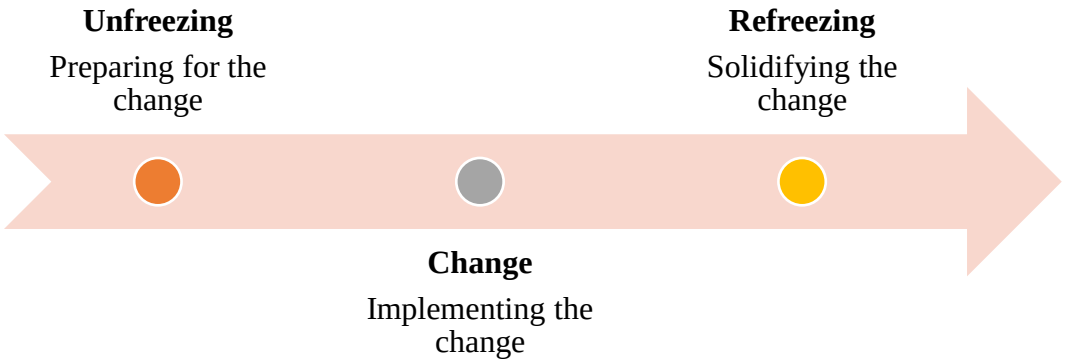

Figure 9 Lewin's change model

ADKAR®

The ADKAR® change model is individual change model that is built on practical research conducted in more than 900 organizations. It consists of five steps that individuals must go through in order to change [75] (Figure 10):

1. **Awareness of the need for change.**

   The goal of this step is to explain why change is necessary in order to prepare employees to accept the proposed change.

2. **Desire to participate in and support the change.**

   In this step, the goal is to prepare employees to support and participate in the change. This goal can be achieved by reaching a full awareness of the need for change and providing appropriate incentives for participation.

3. **Knowledge of how to change.**

   Accepting the change is not enough; employees also need to learn *how* to change. This step aims to transfer knowledge on how to change through training, education, coaching, forums, and/or mentoring.

4. **Ability to implement required skills and behaviours.**

   After learning how to change, the next step is to apply this knowledge in practice. To do this properly, employees need practice, coaching, and feedback.

5. **Reinforcement to sustain the change.**

   This final step of the model helps ensure that changes stay in place and that individuals do not revert to old ways and behaviours. Many methods can be used to sustain change, including positive feedback, rewards, recognition, measuring performance, and taking corrective actions.

The ADKAR® change model has several advantages over Lewin's model:

- It focuses on individual changes and makes sure each individual makes the transition successfully.
- It explains the expected outcomes of each step instead of only explaining what needs to be done.

However, focussing on individual changes limits the model applicability to large-scale change initiatives.

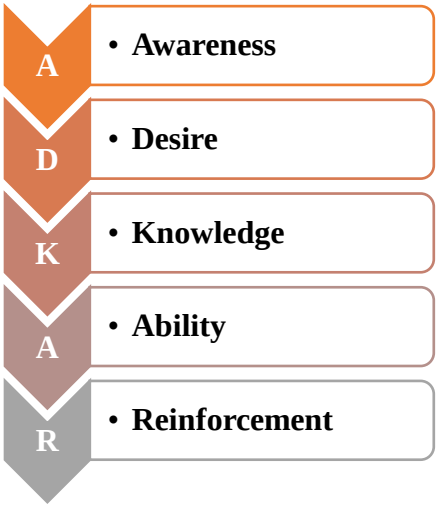

Figure 10 ADKAR® model steps

Kotter's Model

Kotter's model [69] is another well-known approach that was developed based on Kotter's observation and research on change in a wide range of organizations [71]. In Kotter's model, change is divided into three phases: creating a climate for change, engaging and enabling the whole organization, and implementing and sustaining the change. Kotter's model consists of eight steps outlined within the three phases (Figure 11):

- First phase: *Creating a climate for change.*
  1. Establishing a sense of urgency.
  2. Forming a powerful coalition.
  3. Creating a vision.
- Second phase: *Engaging and enabling the whole organization.*
  4. Communicating the vision.
  5. Empowering others to act on the vision.
  6. Planning for and creating short-term wins.
- Third phase: *Implementing and sustaining the change.*
  7. Consolidating improvements and producing more change.
  8. Institutionalizing new approaches.

Figure 11 Kotter's change model. Source [69]

Kotter's model considers both the emotional and situational aspects of the change [76] to help managers deal with resistance among individuals. The model emphasizes the importance of preparing employees to cope with change and the importance of an effective

communication plan to improve that. Despite the proper amount of details, Kotter's model is a top-down approach that may not suit all situations.

In 2012, Kotter expands his eight-step model into eight accelerators [77]. However, the focus and steps remained the same and only the way they are applied has changed. Figure 12 presents the updated model.

Figure 12 Kotter's updated model. Source https://www.kotterinc.com/

Bullock and Batten's model

Inspired by project management, Bullock and Batten [78] developed their change management model, composed of four phases (Figure 13):

1. **Exploration:** Where the answer to "why do we need change?" lies in. It also involves allocating resources that are necessary for the change.
2. **Planning:** Where the actual change steps are decided.
3. **Actions:** Where the agreed-upon change plan is implemented.

4. **Integration:** Where achieved changes are stabilized and embedded.

Bullock and Batten's model provides a suitable technique to communicate with individuals during the change. However, it focuses on the change caused by one issue and implies that the change process is linear and cannot be reversed [79].

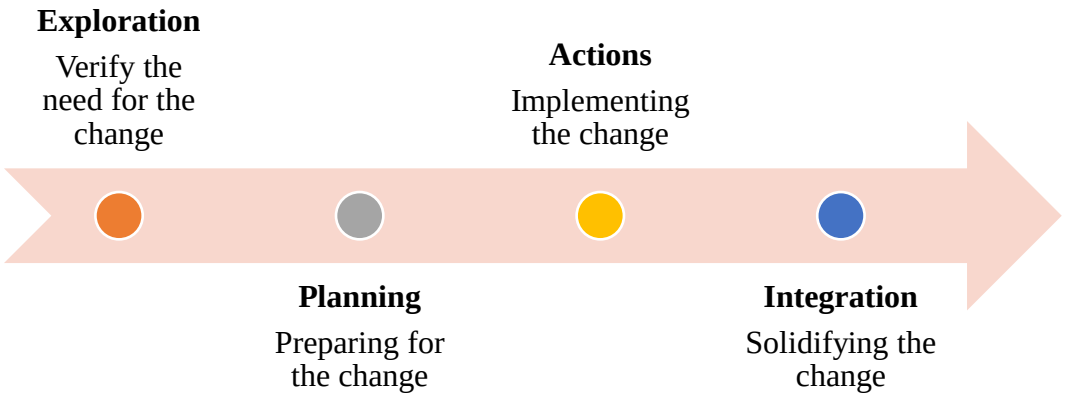

Figure 13 Bullock and Batten's change model

Lippitt's Model

Another famous example of change management models is Lippitt's model [80]. Lippitt's model is an extension of Lewin's model and consists of seven change phases (Figure 14):

1. **Develop need for change**: diagnose the problem.
2. **Change relationship**: assess motivation and capacity for change.
3. **Clarification**: diagnosing the client system's problem.
4. **Alternative routes**: establishing alternative routes.
5. **Transformation**: transforming intentions into actual efforts to change.
6. **Generalizing**: maintain, and stabilizing change.
7. **Terminal Relationship**: terminate the helping relationship.

Lippitt's model focuses on change agents and their role in achieving the change more than the evolution of the change itself [81].

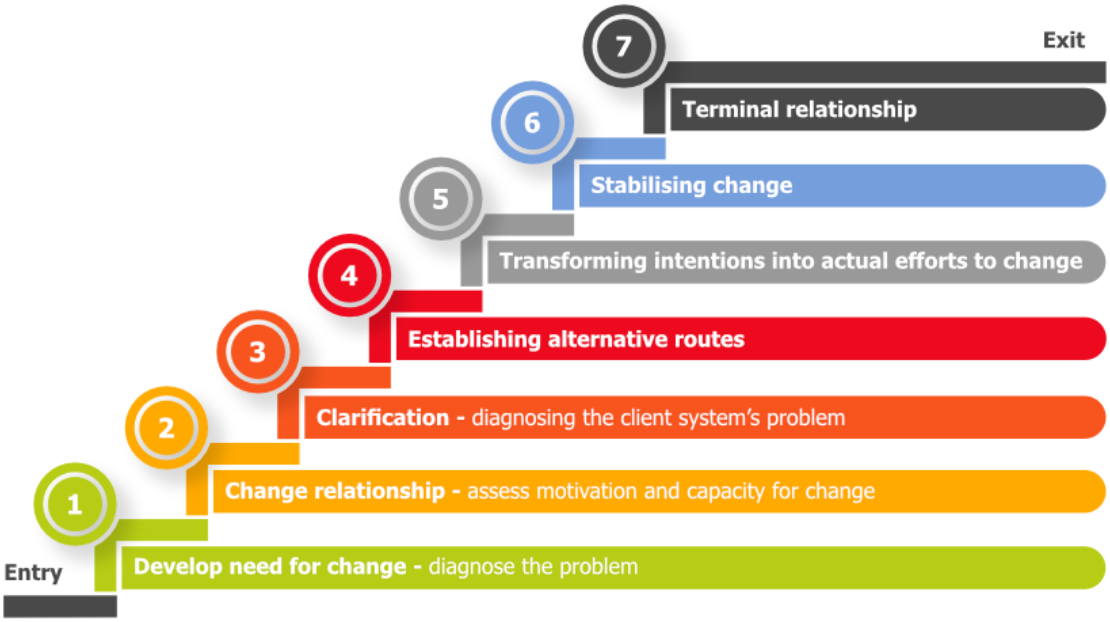

Figure 14 Lippitt's change model. Source: https://bit.ly/3ahfH1M

In summary, despite the existence of different change management models, most of them share many similarities. It is noticeable from Table 4 that the models mentioned above are related to Lewin's 3-step model. The difference between those models lies in the degree of detail each model considers, the degree of consideration for individuals' feelings and experiences during the change and the change scale/scope. For instance, models such as ADKAR® and Lewin's are more suitable to the smaller scale/scope change projects that affect smaller numbers of people. On the other hand, Kotter's model is more appropriate for larger-scale changes that have the potential to impact a large number of people [71].

Additionally, some models focus on how to implement the change and overlook individuals' feelings and the degree of change that affects their routine. Although there is no bad or good change management model, models that engage individuals during change are preferable due to their positive consequences on resistance.

Table 4 Summary of change management models

Lewin **3 Steps**	**Bullock and Batten** **4 Phases**	**ADKAR®** **5 Steps**	**Lippitt** **7 Phases**	**Kotter** **8 Steps**
Unfreezing	Exploration	Awareness	Develop need for change	Establishing a sense of urgency
			Change relationship	Forming a powerful coalition
	Planning	Desire	Clarification	Creating a vision
Change	Action	Knowledge	Alternative routes	Communicating the vision
				Empowering others to act on the vision
		Ability	Transformation	Planning for and creating short-term wins
				Consolidating improvements and producing still more change
Refreezing	Integration	Reinforcement	Generalizing	Institutionalizing new approaches
			Terminal relationship	

2.3.3 Change Management in Healthcare

Change management is being discussed here in the healthcare context, specifically when considering the implementation of technology. Change management application in healthcare appears in three forms: applying established change management models, proposing new change management frameworks specific to healthcare, or identifying change management concepts and principles.

The applicability of Lewin's change management model [70] in health informatics related project at a German university hospital was assessed by Gerrish et al. [82]. In their conclusion, they reported that Lewin's approach was applicable to change management projects in the hospital. However, some specific hospital characteristics that could influence the change model's steps must be considered when planning for change.

Another study that considered Lewin's model was done by Sutherland [83]. The proposed research examined the applicability of Lewin's change management model as a framework for introducing bar-coded medication technology at a large psychiatric facility in Newfoundland. The study results show that the use of Lewin's model would help develop a change plan for implementing the bar-coded medication technology. The plan would help ensure the active participation of nurses in the change process and reduce nurses' resistance and fear of change.

Instead of relying solely on established change management models, experts in the healthcare field tried to propose change management frameworks that emanate from lessons learned and change management key elements. One example of those frameworks is the national change management framework from Canada Health Infoway [19].

The Pan-Canadian Change Management Network has developed this change management framework to guide the change management associated with information and communications technologies (ICT) health projects. The framework incorporates six core change management elements (Figure 15):

- Governance and leadership;
- Stakeholder engagement;
- Communications;
- Workflow analysis and integration;

- Training and education; and
- Monitoring and evaluation.

Figure 15 National change management framework

The framework explains the rationale behind the inclusion of each element, along with resources and tools that can help achieve the goal of each component.

The UK's National Health Service (NHS) provides a guide to support acute care, primary care, and mental health trusts implementing large-scale change through e-rostering or staff bank solutions [84]. However, this guide can be applied to all change efforts within healthcare. The NHS Change Management Guideline is composed of six steps:

Step 1. Know where you're going and why

Step 2. Analyze and design

Step 3. Gain commitment

Step 4. Deliver it

Step 5. Reinforce it

Step 6. Sustain it.

Another type of change management research in healthcare focuses on identifying change management concepts and principles rather than applying established change management

models or introducing new models. This type of research is more popular that the other two types. For example, Nesse et al. [85] discuss the principles of change management for complex adaptive systems (CAS). Detwiller and Petillion [86] present critical change management elements for a successful Clinical Information System (CIS) implementation from their experience in a four-year initiative. Section 3.3 includes more examples of healthcare change management research, specifically those that consider the CPOE system implementation.

Despite the popularity of change management in healthcare, there is still a noticeable lack of a systematic approach that provides detailed steps on how to implement change. Instead, the majority of studies focus on introducing factors and elements that could affect change either positively or negatively. On the other hand, based on a previous literature review [87], a considerable number of studies propose changes to improve clinical processes but do not implement those changes. One possible reason could be the lack of change management knowledge and guides.

2.4. User-Centered Design

The review of technology acceptance theories in Section 2.2.2 shows that individuals' engagement with technology is affected by their perceived usefulness and ease of use of that technology. One of the critical factors that maximize the perceived usefulness and ease of use and improve users' acceptance, utilization, satisfaction, trust, and usability of technology is the involvement of users in the design process of the system [88]. A well-known approach that advocates the role of users' involvement in systems design and implementation processes is *User-Centered Design* (UCD), sometimes referred to as *User-driven Development* (UDD), or *Human-centered Design* (HCD).

UCD is a design philosophy that stresses the importance of early, active, and ongoing input from users to inform iterative development of technologies [89]. UCD was initially introduced by Norman and Draper in 1986 [90]. UCD is a result of research emphasis shifting from the technical aspects of computing to modelling humans' interaction with computers [91], [92]. The goal of UCD is to develop a system with very high usability to the end-user.

UCD is “a multidisciplinary design approach based on the active involvement of users to improve the understanding of user and task requirements, and the iteration of design and evaluation.” [89]. Mao et al. [89] consider UCD as the practice of the following principles:

1. The active involvement of users for a clear understanding of user and task requirements;
2. Iterative design and evaluation; and
3. A multi-disciplinary approach.

UCD focuses on developing a deep understanding of users’ experiences and attitudes, together with an understanding of the context within which systems are used, in order to enhance the usefulness and usability of the developed systems. UCD proposes solutions to traditional systems development approaches issues. Traditional approaches are technology-centered, which often results in gaps between what users want and how the system actually works. UCD was introduced to fill those gaps by having users’ needs drive the system design.

UCD carries many advantages and disadvantages to the users and the designed system compared to conventional design approaches, which are not focusing on users (adopted from [93]).

UCD advantages:

- The development of a usable system that will achieve its intended purpose;
- The development of a more effective and efficient system;
- Better management of users’ expectations about the developed system;
- The development of a sense of ownership for the system; and
- Higher user satisfaction and acceptance of the system.

UCD disadvantages:

- It can be quite costly;
- It takes time;
- It requires a considerable amount of resources; and
- The resulting system can be too specific and overfit, and hence may not be easily transferable to other users or contexts.

User involvement in UCD can be achieved using a spectrum of methods employed at various stages of the system implementation lifecycle. At one end of the spectrum, user involvement can be as easy as participating in requirements gathering and usability testing. At the opposite end of the spectrum, user involvement can have an intensive impact on the design by being partner with designers [93]. A range of methods has been introduced to support UCD, including prototyping, participatory design, surveys, usability testing, and heuristic evaluations. Mao et al. [89] have noted that "UCD methods are modular or identifiable processes involved in UCD practice. You should NOT think of UCD as merely usability testing or software engineering". Each stage of the system implementation lifecycle requires a different set of methods. Choosing the best-fit method requires considering many factors, such as the cost-benefit ratio of applying the methods [89], the stage in the lifecycle, the objectives for the stage, the level of intrusiveness, resource and time constraints, and the immediacy of response [94]. Table 5 presents a set of frequently used UCD methods.

Table 5 UCD methods

Method	Purpose
Focus groups	Face-to-face discussion with a group to gather requirements or obtain feedback.
Observations	The researcher observes and documents information concerning the environment in which the system will be used.
Interviews	Face-to-face discussions with an individual to gather information on various topics.
Questionnaires	Using questions either open-ended, multiple-choice, rating scales, or other formats to gather information on various topics.
Usability testing	Evaluating the system by testing it during its actual use.
Modelling and simulation	Simulating user interaction with the system to predict outcomes of that interaction.
Prototypes	An artifact that visually presents a subset of system features, functions, or screens for evaluation purposes.
Use cases	Narrative descriptions of actions or event steps define the interactions between an actor role and a system to achieve a goal.

UCD is an iterative cycle of design and evaluation. UCD does not have any standard steps per se. Adjustments can be made flexibly depending on needs. However, different variations of UCD processes exist. The following two subsections present examples of standard processes.

2.4.1 UCD Process Steps (for Designing Web Applications)

According to the Web Accessibility Initiative [95], the following steps are an example of a UCD process for designing Web applications.

1. **Analysis** of goals, users, tasks, and workflows.
2. **Design** using paper prototypes, online mock-ups, or functional online prototypes.
3. **Evaluation** using design walkthroughs, heuristic evaluation, guidelines reviews, or usability testing.
4. **Implementation** of the completed design after evaluation.
5. **Deployment** of the designed web application.

2.4.2 UCD Process (General Phases)

According to the US Department of Health and Human Services [96], UCD includes the following general development cycle:

1. **Specify the context of use:** Identifying the environment and users in which the system is being used.
2. **Specify requirements:** Identifying any requirements and possible limitations that can affect design success.
3. **Create design solutions:** Moving from concept to a complete design.
4. **Evaluate designs:** Testing the design with actual users.

2.4.3 UCD in Healthcare

Like other types of technologies, HIT must be carefully designed to meet users' needs and expectations. One recommended way is to employ UCD methods during development and iterative enhancements of HIT. Users' involvement in the development and implementation processes is a crucial factor of HIT success. In 2000, the USA's failure rate for new health information system implementation was about 50% [97]. One of the significant

factors contributing to failure was the insufficient involvement of clinicians in the human-computer interface design [98]. It is worth mentioning that, in healthcare, end users can be patients, not only medical practitioners. Sometimes UCD is called patient-centered design in healthcare. Many of the "homegrown" HIT systems in healthcare organizations have succeeded due to their use of UCD practices; however, commercial HIT vendors do not adopt UCD sufficiently [99].

The introduction of UCD in HIT is dated to 1992 [100]. In their systematic review "user-centered design practices in healthcare", Ghazali et al. [100] reported that UCD had been known in healthcare since 1992, six years after the introduction of UCD approaches. However, UCD started getting popular around 2008. Despite the UCD's roles in improving HIT efficiency, safety, and satisfaction, it is challenging to change the healthcare culture to adopt UCD in HIT development [101].

In their effort to change the healthcare culture towards UCD, Stanziola et al. [101] reflected on the lessons learned through the process. They stated that UCD for healthcare systems must be transdisciplinary, use a methodology that includes aspects of participatory design, and integrate the design of applications in an overall service to avoid disconnected touchpoints.

Most of the research on HIT focuses on the design, development, and evaluations of the systems [102]. Hence, requirements gathering and testing are the most widely adopted stages of the UCD approach. Additionally, Ghazali et al. [100] have conveyed that interview, observation, focus group, and scenario are the most common UCD methods. Figure 16 illustrates an example of the different UCD methods that are used in each phase to develop an interactive diabetes self-management support system on smartphones called Chinese Aged Diabetic Assistant (CADA). The project went through three phases:

- Phase 1: Planning/Feasibility and Requirements.
- Phase 2: Design Phase, which includes three levels of usability testing:
    - Low-Fidelity Paper Prototype and Usability Testing.
    - Mid-Fidelity Prototype and Usability Testing.
    - High-Fidelity Prototype and Usability Testing on the Smartphone (Fully Functional System).
- Phase 3: Test and Measure.

In a nutshell, the use of UCD and its methods in healthcare do not differ from their use in developing other technologies. However, researchers still need to pay special attention to the unique features of the healthcare field and its users.

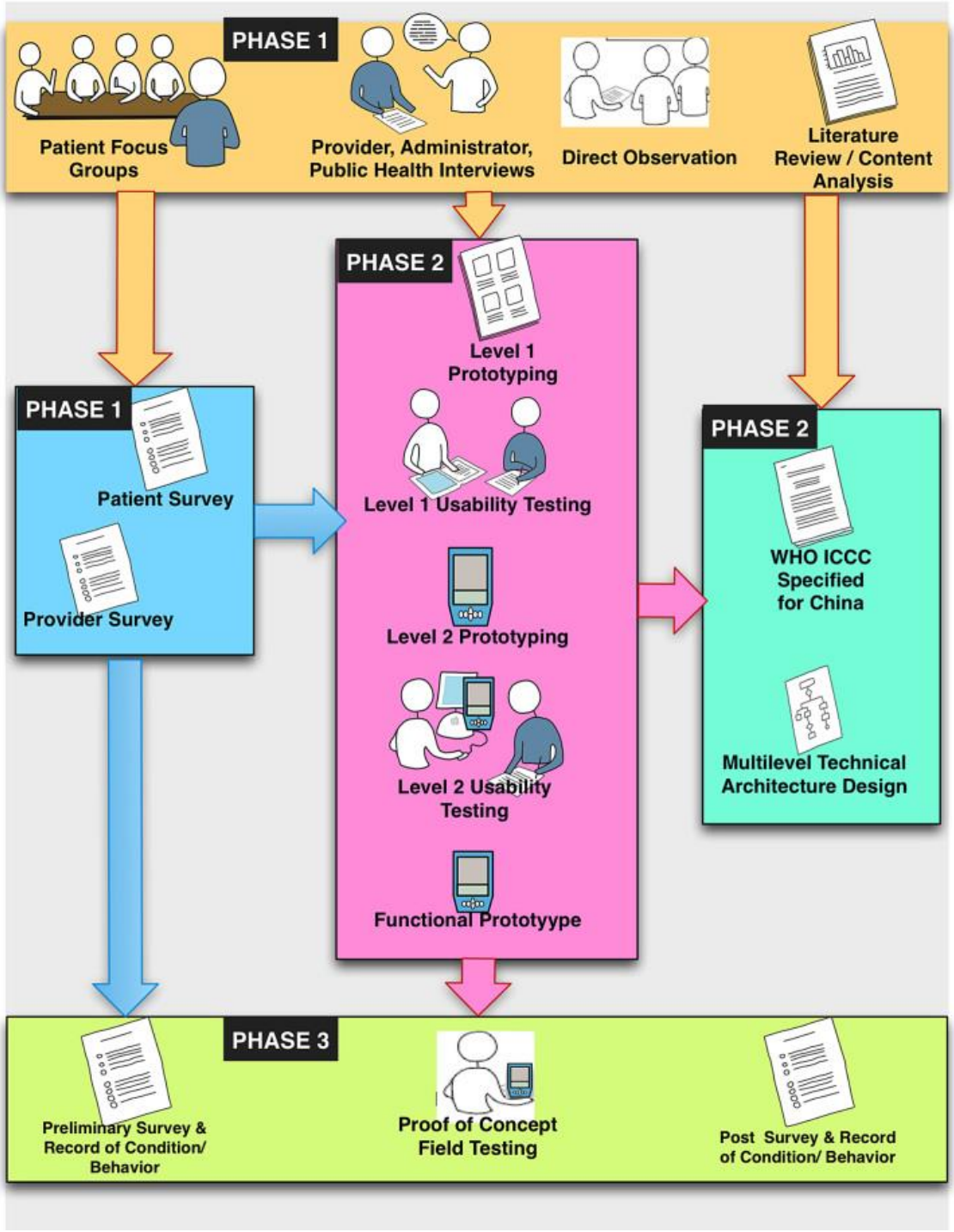

Figure 16 Case study example of UCD techniques across development stages of CADA project. Source [102].

2.5. Chapter Summary

This chapter provided background information about four essential concepts related to the proposed research. The goal of this chapter was to present an introduction to each concept. It included information regarding what a CPOE system is and the benefits and drawbacks of introducing a CPOE system in care delivery.

User acceptance of HIT was explained using the established technology acceptance theories. Despite technology acceptance theories being beneficial in HIT, the unique characteristics of healthcare and its users must be considered because of their possible effects on the technology adoption.

The third concept in this chapter was related to change management models in organizations and healthcare. Almost all organizational change management models have emerged from Lewin's 3-step model. However, they vary in the degree of detail they consider and the degree of consideration for individuals' feelings and experiences during change initiatives. Change management research in healthcare focuses more on concepts and principles, not on developing a systematic, operationalized approach.

Lastly, the chapter briefly introduced UCD, along with its advantages and disadvantages. In the healthcare context, UCD is a great approach to improve the understanding of user and task requirements, and to actively involve users in systems development.

The next chapter is a three-part literature review on factors that affect users' acceptance of CPOE systems, change management during the CPOE implementation and its link to the retrieved factors, and UCD introduction to the CPOE system implementation.

Chapter 3. Literature Review

This chapter presents a systematized literature review of research on related CPOE implementation, change management, and user-centered design literature. The literature review is done in three parts:

1. CPOE implementation and users' acceptance, to cover the reported factors that affect users' acceptance of CPOE systems.
2. Change management in CPOE implementation, to cover the reported use of change management theories during CPOE implementation.
3. User-centered design in CPOE implementation, to assess the current use of UCD in the implementation process of CPOE systems.

3.1. Review Methodology

The primary goal of this review is to examine existing work in order to learn from previous efforts and to avoid duplication, as well as to locate relevant research gaps to be addressed. In order to achieve this goal, the review should be reliable, transparent, and reproducible. For this review, I followed the steps proposed by Kitchenham [26] (shown in Figure 17): 1) Search using queries to locate relevant literature, 2) Evaluate the retrieved publications using predefined criteria to keep the most relevant work, and 3) Synthesize to draw conclusions and categorize similar approaches.

The steps mentioned above were repeated for all the three literature reviews. The following section is a description of the search steps.

3.1.1 Search Methods

This step results in an extensive collection of papers returned from selected databases as a result of the entered keywords. At this stage, the retrieved papers are not all relevant and they need to be filtered.

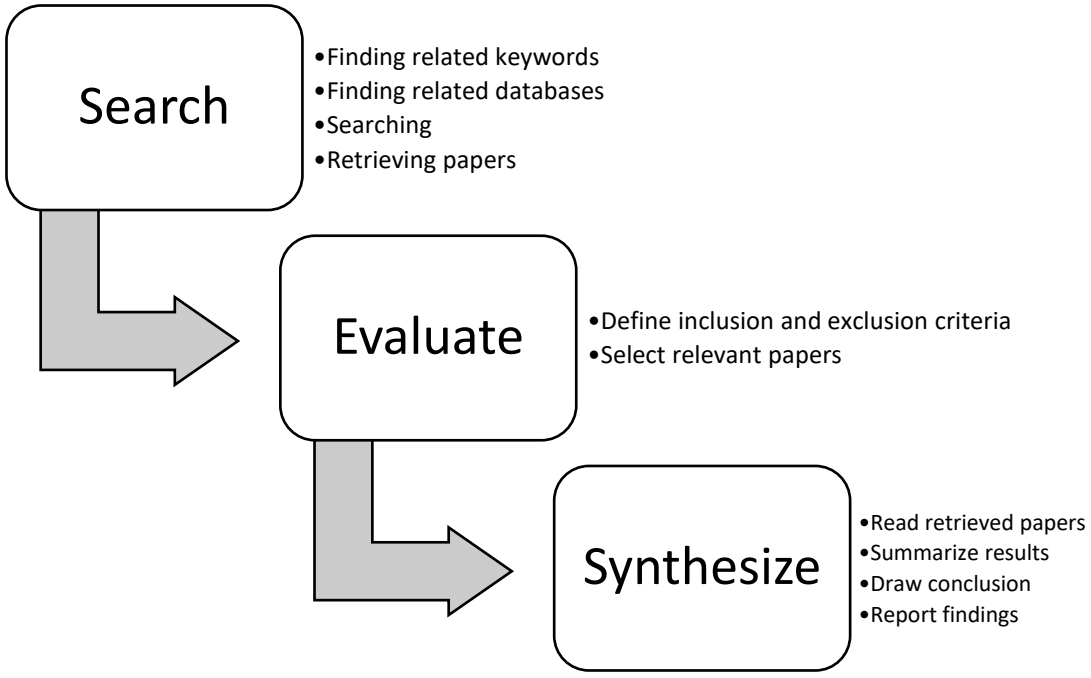

Figure 17 Systemized review steps

Data sources and search queries

The thesis topic is multidisciplinary, at the intersection of three different areas: healthcare, information technology, and management. For that reason, there is a need to include databases that cover those areas either combined or separately. Hence, Scopus, Medline (Ovid), and Web of Science have been chosen. Table 6 shows the research fields for every selected database. Together, these general databases cover over 100 million entries. Additionally, Google Scholar was used as a "catch-all" database, although its query language is limited, and the results include much noise.

In addition to databases searches, reference harvesting (also known as snowballing) was used to search references that were cited in the retrieved articles in order to discover relevant work missed by the databases or queries.

The search contained no constraint related to dates. However, papers from predatory journals and conferences were excluded according to the approach proposed by Janodia [103].

The search queries used in each review are included in each related section. It is worth noting that each database has its own search engines particularities, therefore, the search queries were adapted to the syntax used by each database.

Table 6 Databases research fields

Database	Research Fields
Scopus	Science, engineering, technology, health, medicine, social sciences, arts, and humanities.
Medline (Ovid)	Biomedicine, including the allied health fields and the biological and physical sciences, humanities, and information science as they relate to medicine and healthcare.
Web of Science	Science, social science, arts, and humanities.
Google Scholar	All fields.

3.1.2 Evaluation

Study selection

The study selection process went through the following steps:

1. Running the search query on each of the three selected databases. The search was limited to title, abstract, and keywords in order to avoid having too many false positives.
2. Evaluating the retrieved papers against the predefined eligibility criteria.
3. Scanning references lists of included papers (snowballing) to locate additional related studies that satisfy the eligibility criteria.

After running the queries and collecting papers, the next step is to restrict them to keep only the most relevant ones before the evaluation. To accomplish this, inclusion and exclusion criteria must be defined.

Eligibility criteria

As a guideline to carry out the review, the search was limited to:

- Documents written in English.
- Documents that are fully accessible to the author.

- Article title, abstract, and keywords fields, in order to manage the volume of returned results and keep the most relevant documents.

In addition to those general guidelines, I included gray literature to cover a wider spectrum of research and I excluded papers that:

- Consider other technologies such as electronic medical records (EMR).
- Consider only the CDSS aspect of CPOE systems.

Due to the vast number of returned results using Google Scholar, the search time has been limited to the last five years (2015 - 2020) for that engine. Then, the articles have been selected based on the relevance of their titles.

3.1.3 Results (Synthesizing)

The last step of the review is concerned with reporting the results and building conclusions based on these results. The next sections present the results of each one of the three reviews and then concludes with a chapter summary that summarizes the literature findings and gaps.

3.2. CPOE Implementation and Users' Acceptance

This review aims to identify the key factors that influence clinician's acceptance of the CPOE system by answering the following research question:

Q1: What are the key factors that contribute to clinicians' acceptance of CPOE systems?

3.2.1 Search Query

To investigate the key factors that contribute to clinicians' acceptance of CPOE systems in their healthcare organizations, a set of related keywords were chosen to cover four concepts: CPOE, factors, acceptance, and users. Figure 18 presents the chosen four concepts along with their related (synonymous) keywords. The abstract search query that has been used on the databases, after tailoring to their specific syntaxes, is:

```
( CPOE OR "Computerized Physician Order Entry" OR
  "Computerized Provider Order Entry" OR "Computerized Prescriber Order
   Entry" OR "Computerized Practitioner Order Entry" )
AND ( factor* OR activit* OR facilitat* OR assist* OR drive* )
AND ( accept* OR adopt* OR use* OR usage)
AND ( user* OR clinician* OR nurse* OR physician* OR provider* OR
      practitioner* OR prescriber* OR pharmacist* )
```

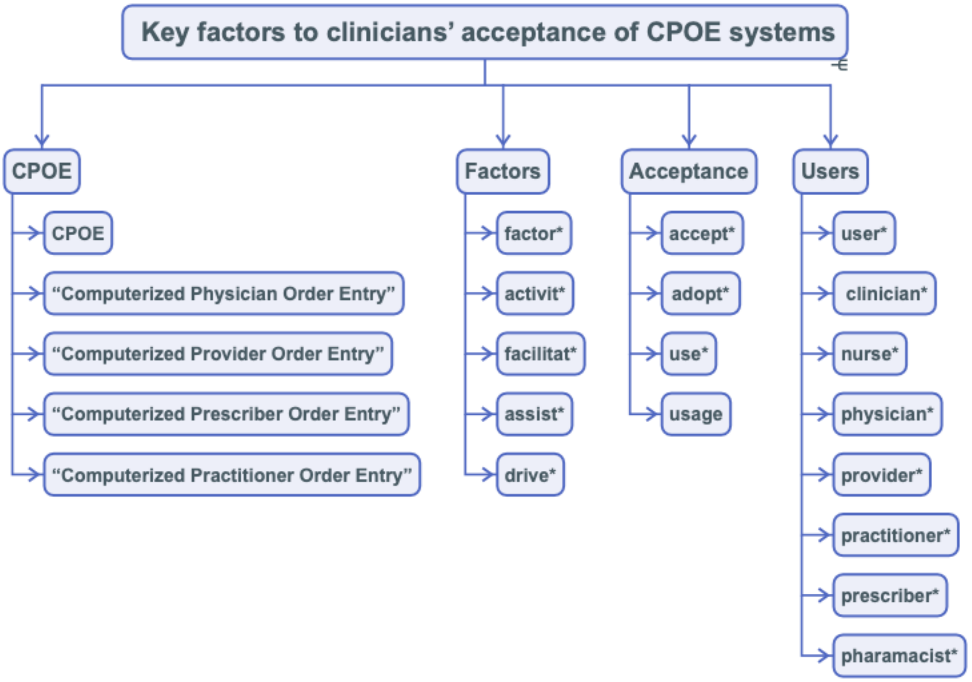

Figure 18 CPOE user acceptance four concepts with keywords/synonyms

3.2.2 Overview of Results

A total number of 23 articles have met the eligibility criteria and were hence included in the review. These articles have been published fairly evenly between the years 2002 and 2018. Figure 19 shows the distribution of articles by year. The majority of the articles (13/23) concerned American organizations, as shown in Figure 20.

Users' acceptance of CPOE is one of the main indications that the system implementation has succeeded. Different studies considered different groups of users and focused on how to satisfy those groups and what factors facilitate or hinder their acceptance. In general, physicians, nurses, and pharmacists are reported as the main users of CPOE

systems. Six of the retrieved studies focused only on physicians and considered them the primary users of the system [104]–[109]. Other studies considered the satisfaction of both physicians and nurses [13], [110]. The third group of studies involved all potential users and reported on different factors that could affect their satisfaction and acceptance of the system [11], [23], [35], [111]–[121]. Three of the studies were focusing on cancer care providers in particular [111], [115], [122].

The reported case studies have covered multiple clinical settings where CPOE systems have been implemented (Figure 21). The majority of these studies were about CPOE implementation in the entire care units. Other settings include pharmacy departments [118] and ambulatory settings [119]. Some of the reported case studies were about CPOE systems that have been explicitly used for specific therapies such as chemotherapy [111], [115], [122]. One of the articles is based on a case study at a company that is developing and commercializing a CPOE system [120].

Because of the importance of clinicians' acceptance of CPOE systems, clinicians' resistance has been identified as one of the most common barriers to CPOE implementation, especially from the physicians' side because they sometimes refuse to see themselves as part of any problem regarding medication errors [13]. Numerous reasons have been mentioned as a possible cause of clinicians' resistance, including fear of change, skepticism about individual benefits, and drastic change in routine workflows, which may lead to an increase in the amount of time it takes to order medication.

The reasons mentioned above are not comprehensive. They are only from articles that consider clinicians' resistance explicitly. The next subsections include a summary of reasons that can lead to clinicians' resistance or dissatisfaction with CPOE systems. In addition, some key lessons from previous case studies meant to facilitate clinicians' acceptance of such systems are discussed.

For the rest of this section, the terms *users* and *clinicians* are used interchangeably.

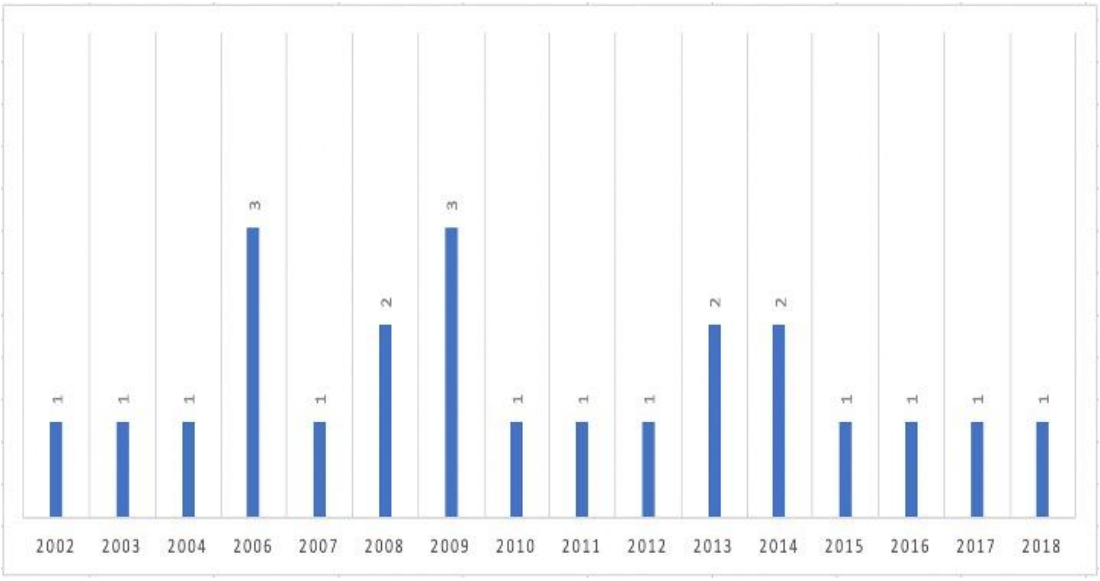

Figure 19 Distribution of articles by year

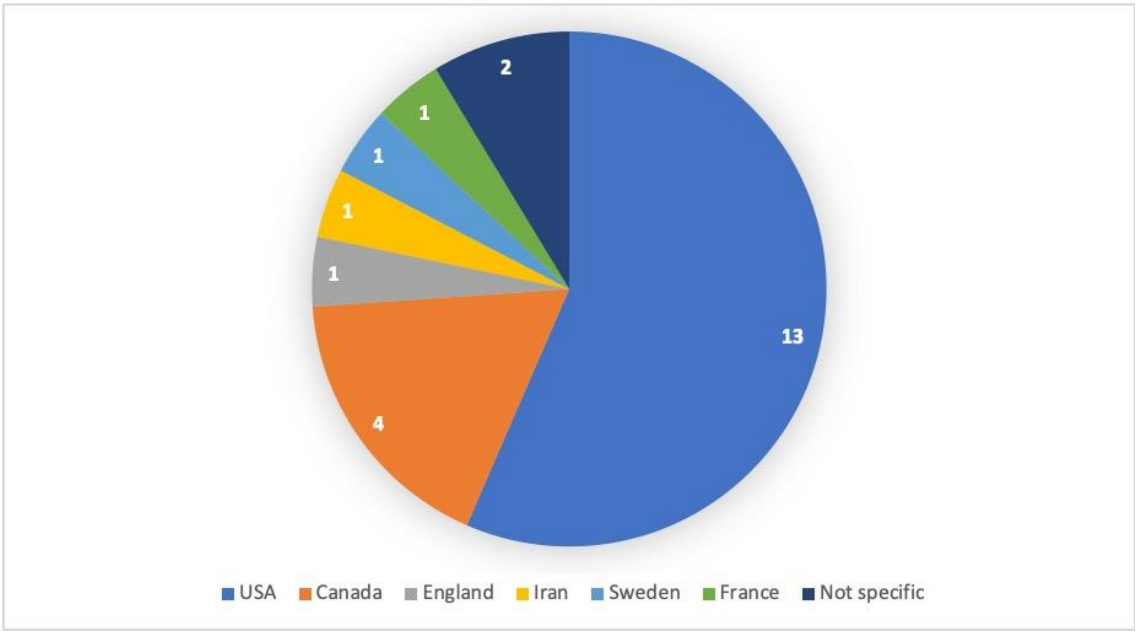

Figure 20 Distribution of articles by location

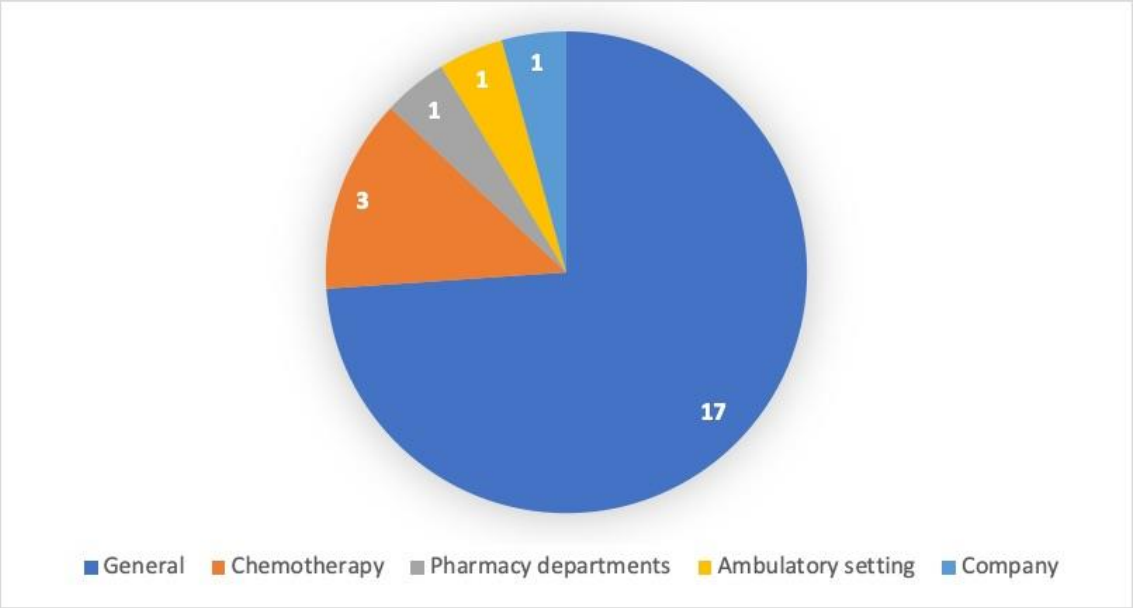

Figure 21 Distribution of articles by setting

3.2.3 Barriers to Users' Acceptance

The successful implementation of a CPOE system is a challenging process for any organization. It requires a dramatic change not only to the way the care is provided but also to the way clinicians work. Because of the complexity of the required change, healthcare organizations must address potential user issues to avoid resistance. Previous studies have identified two types of issues: one related to the used implementation strategy and the other related to how the CPOE system itself was designed.

In addition to the two general types of issues, users' issues can be classified into six areas: resources, workflow, users' perception, users' engagement/involvement, training and support, and usability. The first five areas are related to the implementation strategy, and the sixth area is related to the CPOE system design process. Table 7 presents a summary of CPOE barriers and recommendations. Note that the Special People (I5) strategy category is not counted as a group of barriers in the literature, but recommendations are nevertheless provided.

Dedication of adequate resources (such as people, time, and hardware) is essential for a successful CPOE implementation, specifically to get users' acceptance. Without sufficient resources, users find it challenging to overcome constraints and accept the system, especially if they are on the edge about accepting the system or not. Before implementing

the CPOE system, organizations must make a thorough inventory of all available and needed resources to avoid delay and resistance. Working with limited resources will not only interrupt the implementation [115] but will also affect the development of order sets [118], the adjustment of the CPOE to the new workflows [115], as well as training and maintenance after implementation [118].

CPOE implementation causes a significant change to workflows. It interrupts customary workflows and alters practices. Failing to help users handling the change to their workflows can affect their willingness to accept the system. Users are concerned about productivity loss due to that change [110]. Many studies showed that one of the key reasons behind users' hesitancy to use a CPOE system is that the system disturbed their workflows and was unable to adapt to their work routines [11], [107], [109], [110], [115]. Users should be involved from the beginning in the process of identifying current workflows, required tools to be used in routine work, as well as their requirements and needs. All of that, in the end, will help optimize and streamline workflow processes before CPOE implementation.

Another group of barriers to users' acceptance of CPOE is related to users' perspectives towards CPOE development and implementation. Understanding users' perspectives makes the greatest difference between success and failure. In many cases, expectations were higher than what could be delivered in reality, which can be frustrating to users. Users start using CPOE looking for the promised benefits but when they find out there will be an increase in the amount of time required for placing orders in the system, they may start showing some resistance [104], [107]–[109], [118]. An increase in order time means physicians will see fewer patients per day, which may also mean a decline in their income [104]. In many cases, users perceive the CPOE system as an additional burden that compromises patient safety and, as a result, resist using it [23], [106]. Another issue that triggers fear of CPOE is that using the system will affect face-to-face interaction with patients and reduce care time because of the increase in computer usage time [104]. Furthermore, some users see CPOE as a distraction from their primary goal of providing care [106]. Users are also concerned about their skills and whether they have the capability of learning and using the CPOE system. Inadequate training escalates the concern and the resistance as well [13], [107], [118]. Comprehensive training on CPOE functionalities is a great way to develop

skills. In a nutshell, users' acceptance of the CPOE will increase if benefits and risks to individuals are communicated clearly and honestly prior to the implementation.

Users' limited engagement in system design and implementation planning is another barrier. Inadequate involvement of users means an inadequate representation of their requirements and needs and may affect their acceptance and use of the CPOE system [23]. Additionally, *low-frequency users (LFU) physicians* – physicians who are affiliated with multiple hospitals or consultants who issue less than 10 orders per month [104] – may resist using CPOE due to difficulties in learning and remembering how to navigate through multiple CPOE modules. Healthcare organizations need to figure out ways to encourage and assist LFU physicians use of CPOE, otherwise LFU physicians will refuse to use CPOE and continue issuing orders on paper.

All of the above barriers are resulting from changes in the work environment and the used implementation strategy. On the other hand, other barriers are related to the CPOE system design and its functionalities. Organizations can find ways to optimize workflow, train users, and provide resources to increase users' acceptance. However, after using the system, users often start being impacted by many usability issues. Bad experiences with the system can affect users' acceptance, especially for users on the fence about whether to use the system or not. CPOE usability is crucial to ensure acceptance of the system because of its possible severe impact on patient safety. Usability issues include poor software interface [122], too many alerts and warnings that can lead to alert fatigue [35], [104], [115], [118], [122], discrepancies in documentation, lack of appropriate safeguards [115], [122], lack of customization of CPOE to suit users' needs, inflexibility of software applications [105], frequent changes in log-in or password requirements [107] interoperability of the CPOE system with existing systems [118], [122] , and many other post-implementation issues that cannot all be covered as they are different from one location to another and from one system to another. A great number of CPOE usability issues could be due to the lack of proper pilot testing with a group of potential users. Organizations need to run true pilot tests and not only provide a trail of the implementation process [11].

3.2.4 Recommendations to Improve Users' Acceptance

Different studies offer different recommendations to consider when implementing CPOE

systems. Some recommendations are unique to particular cases, and some are reoccurring in multiple cases and can be generalized to other projects. In this section, discovered recommendations are summarized and categorized again into two parts: implementation strategy recommendations, and CPOE system design recommendations. The second-last column of Table 7 presents a summary of these recommendations.

Underestimating the workforce/resources necessary to implement CPOE can hinder the users' acceptance of the system. Healthcare organizations should plan proactively the provision of required workforce/resources before starting the actual implementation [118]. Such proactive planning will not only improve the implementation process but will also increase users' confidence in the reliability and integrity of the system. Each healthcare organization has its specific practices and workflows, including different processes of ordering, preparation, administration, and documentation of patient care. Knowledge of current workflows facilitates the integration of CPOE to the proper workflow, which will improve the efficiency and safety of processes, and in turn increase users' acceptance of the system. To avoid disparities between the CPOE workflow and the real world, current workflow processes should be optimized and streamlined before implementation [11], [105], [112], [115], [118], [119].

Another important group of recommendations is concerned with managing users' perception of the system and its implementation process, including leadership engagement and continuous support [7], [11], [13], [23], [111]–[114], [117]–[119]. Leadership engagement and commitment reassure users that adequate resources are provided to facilitate their use and acceptance of the system. One of the important change management principles is that major changes cannot be achieved without active engagement and support from the top leadership [69]. Other recommendations include creating a clear vision and communicating it well to users so they can have a clear sense of the desired goal [13], [117], as well as performing needs/requirements assessments to understand the change process better and to ensure system compatibility with users' needs, which will contribute to better levels of satisfaction about and usage of the CPOE system [120]. In addition, frequent, accurate, and timely communication with users before and after the CPOE implementation is another crucial step [11], [13], [23], [35], [105], [106], [109], [113], [117]–[119], [122]. Through good communication, many barriers to users' acceptance will be mitigated, specifically

those related to the possible benefits of the system to the users and the possible changes they will go through during the transition. Communication can be done through multiple channels, including regular meetings with users, emails, posters, etc. Additionally, eliminating dual ordering processes by replacing written orders entirely with CPOE [114] can improve users' perception towards CPOE.

Providing incentives is another recommendation to manage users' perception of the system. Incentives can take the form of a direct payment or of the inclusion of CPOE performance as a contractual obligation [7]. Gellert et al. [7], in their report about experiences with CPOE implementations in four hospitals, reported that including CPOE performance/use metrics in physician group contracts has led to a consistent 82–88% month-over-month CPOE overall facility use rates in comparison to 55–70% before.

Engaging all potential users in every step starting from planning to development, implementation, and refinement [7], [23], [105]–[107], [109], [111]–[115], [117]–[120] has been mentioned in many studies. In fact, this is the most frequent recommendation. Gellert et al. [116] advise considering users as customers, i.e., "*customer-centricity*", and collect their requirements. The involvement of users has many positive effects, including adjusting CPOE functionalities to match user requirements, which will result in higher levels of satisfaction and use of the system in the long run. Involving users in every step of the implementation goes beyond collecting their requirements. This is about empowering users to lead the change and make decisions. In the end, involving users in the process gives them a sense of ownership of the system and, as a result, they will more likely accept and use the system [111].

Assembling a group of powerful and knowledgeable members to build a functional implementation team is another key contributor to users' acceptance. The team should include a representative for each key stakeholder type to be effective. The team should also include special people [13], [113] who play important roles, such as superusers who are highly trained users to provide live, in person, and "*at-the-elbow*" support to other users [7], [11], [13], [113], [117], [118], physician health informatics liaisons to build trust and engagement with other physicians [7], [11], [13], [114], and champions for the system to encourage the use and acceptance of the system [11], [13], [113], [116].

Dedication of adequate resources and time for training, technical support, system troubleshooting, and maintenance has appeared in many articles as an essential recommendation [7], [11], [107], [109], [111], [114], [115], [117]–[119], [121]. One essential step to convince users to use CPOE is to train them on how to use the system and benefit from its many functions. The training plan should start early, even before the implementation starts, and it should include multiple methods of training to cover a wide range of learning skills and abilities among the users. Training also should continue after implementation to cover new users and to cover new updates to the system [119]. In some cases, training can be extended to include basic computer training for some users [117]. In addition to training, ongoing support is fundamental to facilitate users' acceptance. Support is not limited to one specific form. It can combine super users, help desks, web-based support, conference calls, and the presence of a conventional IT team. Good support should include continuous measurement of success to monitor and further fine-tune the system [11], [13], [118] continuous evaluation and correction to help ensure that users do not return to manual order entry again and a clear mechanism to respond to users' feedback after implementation. The last recommendation related to support is to provide an appropriate form of support to LFU physicians. Gellert et al. [104] provide a list of six facility options to support LFU physicians along with each option cost to the facility.

Usability importance for users' acceptance and use of CPOE cannot be overemphasized. Ensuring CPOE system usability should be among the top priorities when implementing the system. As discussed before, poor system usability damages user interest in the system. The first recommendation to ensure good usability is to perform a pre-implementation usability test with users and learn from their feedback [7], [23], [118]. The second recommendation is to ensure system usefulness and ease of use, and that includes a consistent and user-friendly interface [105], [114], [118], [121]. The third recommendation, which can be another example of ease of use or can be a standalone point, concerns the consolidation of similar order sets that are tailored to the hospital's clinical workflows [114], [115], [118]. According to the literature, the concept of CPOE usability is not limited to the ease of use of the system but it also includes the usability of the system in the work context [18]. So, the fourth recommendation is to integrate the CPOE system to the local context in order to eliminate inefficient and poorly fitting functions [13], [23], [105]. The

fifth recommendation is to select a CPOE system that provides interoperability with existing information systems [118].

In conclusion, this review was about looking for factors that can positively or negatively affect clinicians' acceptance of the CPOE system. Based on what was retrieved from the literature, I can answer the research question:

Q1: *What are the key factors that contribute to clinicians' acceptance of CPOE systems?*

From the 23 papers reviewed, a total of 28 barriers and 25 recommendations for clinicians' acceptance of CPOE systems (summarized in Table 7) were retrieved. I choose to include both barriers and recommendations to identify both negative and positive factors that can make a difference in how clinicians accept and experience CPOE systems.

Table 7 Summary of key factors of clinician's acceptance of CPOE systems in the form of barriers and recommendations, along with references and timeline

	Barriers	Year(s)	Recommendations	Year(s)
Implementation strategy				
Resources (I1)	Limited workforce [115], [118]	2012, 2018	Proactive planning to provide the required resources [118]	2012
	Unavailability of appropriate hardware [107]	2011		
	Inadequate number of dedicated staff for different tasks [23], [107], [118]	2011, 2012, 2017		
	Limited resources for the development of CPOE order sets [118]	2012		
Workflow (I2)	Disruption to workflow [11], [107], [109], [110], [115]	2006, 2008, 2009, 2011, 2018	Workflow optimization before CPOE implementation [11], [105], [112], [115], [118], [119]	2004, 2008, 2010, 2012, 2014, 2018
	Incorrect integration of CPOE with proper workflow [104], [110], [115], [122]	2009, 2014, 2016, 2018		
Users' perception (I3)	Time consuming in comparison to paper [108], [109]	2006, 2009, 2011, 2012, 2016	Leadership engagement [7], [11], [13], [23], [111]–[114], [117]–[119]	2002, 2003, 2004, 2006, 2008, 2010, 2012, 2013, 2015, 2017
	Increased workload [106]	2013	Clear vision [13], [23], [117]	2006, 2013, 2017
	Patient safety jeopardized [23], [106]	2013, 2017	Frequent, accurate, and timely communication [11], [13], [23], [35], [105], [106], [109], [113], [117]–[119], [122]	2003, 2006, 2007, 2008, 2009, 2010, 2013, 2014, 2017
	Interaction with patients interrupted [104]	2016	Planning for regular meetings to address users' fears and explain the change process [7], [23]	2015, 2017
	Fewer patients seen [104]	2016	Provision of incentives [7]	2015
	Decline in salary [104]	2016		
	Perceived individual benefits [11], [23], [106]–[108]	2008, 2009, 2011, 2013, 2017		

	Barriers	Year(s)	Recommendations	Year(s)
	Perceived usefulness [11], [23], [106]–[108]	2008, 2009, 2011, 2013, 2017		
User's engagement/involvement (I4)	Limited user engagement [23]	2017	Engagement of users in every step [7], [23], [105]–[107], [109], [111]–[115], [117]–[120]	2002, 2003, 2004, 2006, 2010, 2011, 2012, 2013, 2014, 2015, 2017, 2018
	Low-frequency users (LFU) physicians [104]	2016	Performing of needs/requirements assessments [120]	2010
			Empowering users [107], [112], [114]	2002, 2004, 2011
Special people (I5)			Building an effective implementation team [7], [11], [13], [112], [114]	2002, 2004, 2006, 2008, 2015
			Training superusers [7], [11], [13], [113], [117], [118]	2003, 2006, 2008, 2012, 2013, 2015
			Appointing champions [7], [11], [13], [113]	2003, 2006, 2008, 2015
Training and support (I6)	Inadequate skills and confidence [13]	2006	Dedication of adequate resources and time for training, technical support, system troubleshooting, and maintenance [7], [11], [13], [23], [35], [107], [109], [111], [112], [114], [115], [117]–[119], [121]	2002, 2004, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2015, 2017, 2018
	Inadequate training [13], [107], [118]	2006, 2011, 2012	Measurement of success [11], [13], [118]	2006, 2008, 2012
			Respond to users' feedback after implementation [23], [118]	2012, 2017
			Including basic computer training (if necessary) [117]	2013
			Planning for follow-up training [119]	2010
			Elimination of dual ordering processes [114]	2002

	Barriers	Year(s)	Recommendations	Year(s)
			Support LFU physicians [104]	2016
CPOE System ***Usability issues (U)***	Poor usability [35], [104]	2007, 2014, 2016	Pre-implementation usability test [7]	2015
	Suitability of alerts and warnings (alert fatigue) [35], [104], [115], [118], [122]	2007, 2012, 2014, 2016, 2018	Assurance of system usefulness and ease of use [105], [114], [118], [121]	2002, 2009, 2012, 2014
	Discrepancies in documentation [115]	2018	Consolidation of similar order sets [114], [115], [118]	2002, 2012, 2018
	Lack of appropriate safeguards [115], [122]	2014, 2018	Integration of CPOE to the local context [13], [23], [105]	2006, 2014, 2017
	Lack of customization of CPOE [105], [118]	2012, 2014	Interoperability with existing systems [118]	2012
	Inflexibility of software applications [105]	2014		
	Frequent changes in log-in or password requirements [107]	2011		
	Poor software interface [122]	2014		
	Poor interoperability of the CPOE system with existing systems [118], [122]	2012, 2014		
	Lack of proper pilot testing [11]	2008		

3.3. Change Management in CPOE Implementation

3.3.1 Search Query

This review aims to find how change management theories have been incorporated during CPOE implementation in order to enhance users' acceptance of the system by answering the following research questions:

Q2: What is the change management role in enhancing users' acceptance of the CPOE system?

Q3: What is the relationship between the discovered acceptance factors and existing change management strategies?

To answer the above questions, the following query has been used to retrieve related articles:

```
(CPOE OR "Computerized Physician Order Entry" OR "Computerized Provider Order Entry"
 OR "Computerized Prescriber Order Entry" OR "Computerized Practitioner Order Entry")
AND
("change management")
```

3.3.2 Results and Discussion

The implementation of the CPOE system requires a significant change in an organization's operations and a full commitment from leadership, staff, and clinicians to succeed. The literature is rich in case studies on the implementation of CPOE systems and the transition process from paper-based orders to digital orders. Most of the existing work realized the importance of managing change in the advancement of CPOE implementation.

The search query mentioned previously has returned many useful results. It is clear that CPOE implementers incorporate most of the change management principles without considering the term "*change management*" or any specific change management model. Since change management is mainly about managing the people side of the project, the retrieved articles from the previous review in Section 3.2 have been included as well to ensure full coverage of the topic.

From a first pass at the retrieved articles, it can be seen that the recommendations, I1-I6, on how to improve users' acceptance are in fact change management fundamentals. See the second-last column of Table 7.

One of the works that consider CPOE implementation as an organizational cultural transformation comes from Upperman et al. [20]. Their work promotes the management of changes that are accompanying the introduction of CPOE as a crucial step to successful CPOE implementation. In order to alleviate the possible drawbacks of the transition, Upperman et al. [20] offer a list of change management guidelines to consider when implementing a CPOE system:

- Emphasizing executive leadership;
- Defining goals;
- Assessing the impact of CPOE on users and organizations;
- Integrating all organizational levels in the project;
- Redesigning the processes;
- Ensuring effective communication;
- Recognizing and addressing each individual's fear of change;
- Anticipating consequences of each process step;
- Planning for extensive training;
- Providing enough resources;
- Considering the system limitations; and
- Communicating the possible negative effects in addition to the benefits.

Most of the reviewed articles were discussing the same points as the ones above. Table 8 gives a summary of change management principles that have been considered in the CPOE implementation literature mapped to the corresponding implementation strategies from the previous review.

Table 8 Summary of change management principles in CPOE

Change management principles	References
Users' involvement (I4)	[7], [20], [23], [105], [109], [115], [118], [123]–[125]
Efficient training and support (I6)	[11], [20], [107], [109], [115], [116], [118], [124], [126]
Effective communication (I3)	[11], [13], [20], [105], [109], [110], [123], [124]
Leadership engagement (I3)	[11], [13], [69], [114], [116], [123], [126]
Workflow optimization and process redesign (I2)	[11], [13], [20], [115], [118], [123]
Superusers identification (I5)	[23], [116], [117], [124], [127]
Champions (I5)	[7], [13], [123], [125]
Resources allocation (I1)	[20], [123], [124]
Clear vision (I3)	[20], [110], [123]
Multidisciplinary change team (I5)	[13], [123]
Incentives (I3)	[7], [125]
CPOE motivation (I3)	[123]
Requirements analysis (I4)	[123]

Involving users through the change process comes at the top of the list. Most, if not all CPOE implementation projects confirmed the significance of users' involvement in the success of their projects. Training and support are in second place. A massive consensus on the crucial role of training and support in the success of CPOE implementation has been reported. In third place comes effective communication about the project vision, goals, benefits, and drawbacks. Actually, communication can be seen as part of users' involvement because its main goal is to inform users about the different changes that can affect their regular work. The fourth place in the list is occupied by leadership engagement, which is necessary to ensure the availability of sufficient resources and support to produce the required outcomes. Lastly, workflow optimization and process redesign take the fifth place in the list. The list then continues with the least frequent principles.

So far, all the reviewed articles are talking about how the use of change management principles enhanced user's acceptance of the CPOE system and in turn enhanced its chances of success. However, Noteboom [3] presented an example of a poor change management effort and how it caused physicians dissatisfaction. The author pointed out some change management barriers such

as lacking effective training for physicians, overlooking physicians' requirements, and failing to communicate effectively with physicians about the possible increase in their workload.

3.3.3 CPOE Factors Linked to Change Management

This section discusses the relation between the retrieved acceptance factors and change management, specifically Kotter's model. Section 2.3.2 includes more details about different change management models.

By comparing Kotter's model with the retrieved recommendations from Table 7, I detect many similarities and much overlapping. In the following, I will go through every phase of Kotter's model and explain how it is linked to some of the surveyed acceptance factors.

The **first phase** is about preparing the organization and its entities for the coming change, starting by creating a sense of urgency about the current situation and the need to embrace the change. The main goal is to get buy-in from important parties who can either support or oppose the proposed change. The next steps involve building a powerful team to lead change, defining a vision to direct the change and determine its center values, and finally creating strategies for achieving that vision.

From the retrieved clinicians' key factors, the user's perceptions and special people categories cover most of the steps to create the right change climate. Leadership engagement is an indication of the change urgency and importance of the CPOE system. Creating a promising and realistic vision about the care future using CPOE is another important factor. To form a powerful implementation team, CPOE recommendations include forming a group of special people to help in planning and making the CPOE implementation smooth for the organization and the users.

The **second phase** in Kotter's model is to engage and enable the organization. This starts by communicating the created vision frequently and powerfully, taking every opportunity to apply the vision to all aspects and to set examples by the change team. After accepting the change and believing in its vision, involved individuals will start acting on it. To encourage them, three main points are necessary:

- Getting rid of barriers that can hinder the change advancement;
- Changing systems and structures that do not support the vision; and
- Encouraging innovative ideas and activities.

The last step in engaging the whole organization in Kotter's model is to plan and create short-term wins. Change projects are normally big projects that take time to be completed. Interested entities may lose interest due to the long waiting period. In order to keep the positive energy, managers should plan for and create *visible* performance improvements, and recognize entities rule in those improvements and incentivize them accordingly.

The importance of the users' engagement and enablement is represented in the discovered users' acceptance factors. That includes frequent, accurate, and timely communications. Other factors include empowering users by removing resources and workflow obstacles, addressing users' fear during regular meetings, involving them in every step, and collecting their requirements. Moreover, this also links to creating a measurement of success and providing suitable incentives. All those factors are a clear representation of the resemblance between CPOE acceptance factors and Kotter's model.

The **third and last phase** of Kotter's model is to implement and sustain the change. After implementing all the required changes, half of the battle is done; the other half is to make these changes stick and become part of the organization's normal routine. Individuals in charge of change should continue producing more changes by revising different policies, routines and/or structures. Hiring, promoting, training, and retraining employees are other important steps to keep the implemented vision alive. The goal of this phase is to embed the change in the very culture of the organization.

From the CPOE implementation projects, the recommendations from the training and support category are necessary steps to sustain changes brought by CPOE implementation. These recommendations include responding to users' feedback after implementation, retraining users if required or when new features are added to the system, and eliminating any need for using paper-based charts by providing enough support for LFU physicians.

From the review above and Table 9, it is noticed that there are many similarities and much overlapping between clinicians' CPOE acceptance factors and Kotter's change management model.

Most of the retrieved factors under the *implementation strategy* matched the principles of change management in how to prepare and include users in the change process to get their approval and acceptance. The match may not be exhaustive to every single detail, but it covers the high-level principles. For example, for the third phase of Kotter's model, "implementing and sustaining

the change", CPOE key factors do not include many recommendations. In addition, the remaining group of factors that are related to *usability issues* is related to the technology itself and not to the organization. However, this remains an important factor that should be considered during the change. A lack of usability can be treated as an obstacle that needs to be mitigated to make clinicians' tasks as easy and pleasant as possible.

Table 9 Links between CPOE acceptance factors and Kotter's model

Phase	Kotter's Steps	CPOE Acceptance Factors
1	Establishing a sense of urgency	• Leadership engagement (I3)
	Forming a powerful coalition	• Building an effective implementation team (I5) • Appointing champions (I5)
	Creating a vision	• Clear vision (I3)
2	Communicating the vision	• Frequent, accurate, and timely communication (I3)
	Empowering others to act on the vision	• Proactive planning to provide the required resources (I1) • Workflow optimization before CPOE implementation (I2) • Planning for regular meetings to address users' fear and explain the change process (I3) • Engagement of users in every step (I4) • Performing of needs/requirements assessments (I4) • Empowering users (I4)
	Planning for and creating short-term wins	• Provision of incentives (I3) • Measurement of success (I6)
3	Consolidating improvements and producing more change	• Dedication of adequate resources and time for training, technical support, system troubleshooting, and maintenance (I6) • Planning for follow-up training (I6)
	Institutionalizing new approaches	• Elimination of dual ordering processes (I6) • Support LFU physicians (I6)

3.3.4 Conclusion

In this review, my aim was to examine the role of change management during the CPOE system's implementation. Based on what was retrieved from the literature, I can answer the two research questions.

Q2: *What is the change management role in enhancing users' acceptance of the CPOE system?*

Change management plays an important role in enhancing users' acceptance of the CPOE system. Actually, change management fundamentals are very similar to factors that facilitate users' acceptance of the CPOE system, as shown in the second-last column of Table 7 and the first column of Table 8.

Q3: *What is the relationship between the discovered factors and existing change management strategies?*

To answer this question, I chose Kotter's 8-step change management model as a base to compare its steps and the discovered factors. I found that most of the factors are in fact known principles in change management. The major differences are in the level of detail related to how to achieve the steps and to the chosen terms used to describe those steps. I also realized that the systematic incorporation of change management principles during CPOE implementation will support clinicians' acceptance of the system and reduce their resistance. However, such incorporation comes with a price. It may require extra cost to hire experts in change management and to communicate changes to clinicians in an ideal way. The larger the organization, the larger the cost. From another angle, this extra cost could save organizations more money in the long run by increasing the CPOE project's success probability. Appropriate cost-benefit trade-offs must be analyzed.

3.4. User-Centered Design in CPOE Implementation

3.4.1 Search Queries

The goal of this review is to search existing work that considers using UCD in the CPOE system's implementation process, or in the change management context. From this review, I aim to answer the flowing research questions:

Q4: Is there evidence about using UCD during the CPOE system's implementation process?

Q5: Is there evidence about using UCD in the change management context?

To answer the above research questions, two queries have been used:

Query one:

```
(CPOE OR "Computerized Physician Order Entry" OR "Computerized Provider Order Entry"
 OR "Computerized Prescriber Order Entry" OR "Computerized Practitioner Order Entry")
AND
("User Centered Design" OR "User-centered design" OR "User-centred design" OR
 "User centred design")
```

Query two:

```
"Change Management"
AND
("User Centered Design" OR "user-centered Design" OR "User-centred design" OR
 "User centred design" OR "human-centered")
```

3.4.2 Results and Discussion

This third review aims to examine the literature and retrieve important previous work that applied UCD principles when planning for the change associated with CPOE implementation. To achieve this goal, the first query has been used. However, all the retrieved articles were discussing the application of UCD principles and methods to design the *system* itself, especially with heuristic evaluation and usability tests [128]–[132], which are out of the scope of this thesis. For that reason, the research has been expanded to include any article that considered using UCD during change management.

The second query, which considered the idea of using UCD approaches to design a change management plan, has not returned any relevant article. Most of the retrieved articles are considering it the other way around, that is, change management practices are used to introduce UCD approaches into organizations [133], [134]. Yet, Mashapa et al. [135] have introduced a User Experience Management Requirements framework to manage the experience of users during the introduction of change. The proposed framework integrates change management practices to influence the *design* of products for positive user experience. The goal here is to manage the change in

user experience that results from adding or/and improving product features and changing user interfaces.

Another article from Kim et al. [136] investigated empirically the association between organizational factors, including organizational culture, organizational learning, and change management, and the UCD performance in organizations. The goal was to support a successful institutionalization of UCD within an organization by integrating organizational factors into the UCD process. In their results, they found that change management strengthens the positive relationship between organizational learning and UCD practice performance, but it has no effect on the relationship between organizational culture and UCD practice performance.

In conclusion, much of the published research has considered using UCD approaches during the design and development of CPOE systems and not during the implementation. So, the answer to ***Q4*** (*Is there evidence about using UCD during the CPOE system's implementation process?*) is no.

For ***Q5*** (*Is there evidence about using UCD in the change management context?*), the review showed that there is no evidence on the use of UCD in the change management context. However, change management has been used to support the integration of UCD approaches in organizations.

Nevertheless, to answer this question, I have searched Google to locate any article or website that considers UCD and change management. The following section presents the search results.

3.4.3 User-Centered Change

The gray literature includes several articles that discuss the idea of user-centered change management using different terminologies such as user-centric, employee-centric, or people-centric change management. Table 10 presents a summary of the retrieved articles.

The first article, titled *People-Centric Change Management*, was written by Marsh and Sayre for the Work Design Magazine [137]. The article suggests four strategies that could help managers when implementing change in their organizations:

1. **Build trust through engagement:** by understanding the source of peoples' resistance, by addressing it, and by reminding them of how they have adapted to a non-optimal situation many times before.

2. **Practice participatory design:** to have buy-in from people by asking them questions about their needs and what they think about the proposed change.
3. **Start smart, get even better:** by considering stakeholders' feedback through a pilot program.
4. **Empower change leaders:** managers need to spot and empower employees who would like to participate in shaping the change actively. Those change leaders have an essential role in supporting the change by showing others how to make the change successfully and by providing constructive feedback to improve the change proposal.

In conclusion, the authors state that effective change management should be a mix of top-down and bottom-up strategies. In their words, "The key to a successful change management effort is to engage with people as often and as genuinely as possible. They must be allowed to have a real impact on what will happen to them and, when possible, to take a leadership role in the transformation."

Another article that considers employee-centric change management is *Why Change Management Processes Need an Employee-Centric Approach*, written by Williams [138]. The author introduces five ways to ensure a successful and seamless transformation by adopting employee-centric change management processes.

1. Engaging Employees in Co-Created Design
2. Driving Transformation with Change Leadership
3. Shaping a Change Culture
4. Embracing the Human Side of Change Management
5. Implementing Corporate Training Programs

Inspired by the principles of UCD, Dietze, in her post *Putting people front and center: user-centered change* [139], suggests that putting people front and center will more likely encourage them to engage with the change. The author provides four guidelines on how to apply user-centered design principles to create organizational change.

1. Understanding the problem either by observing the situation on hand or using user stories.
2. Solutioning by experiments, following iterative approaches. Managers can design an experiment and gather feedback to improve the experiment.

3. Road mapping for targeting by designing experiments step by step, keeping in mind the target state.
4. Scaling success across the company.

Lastly, Lafrance shared slides on a *User centric change management* process [140]. This process includes:

1. Co-designing change state: Early prototyping and enactment of the future state to elicit new behavioural solutions and amend the future state.
2. Co-designing change methods: Designing change management communications, artifacts, and experiential learning activities.
3. Embedding change: Deploying the change methods and training (communications, artifacts, and tools).
4. Benefit realization: Proving the effectiveness of the change and of the new design.

The slides show two ways of implementing the process; however, these slides were abstract and needed more elaboration. I was unable to find a full article that considers the same title.

From the above examples, it is clear that coming up with better communications or explaining the reasons for the change [139] to convince people to adopt change is not enough anymore. There is a demanding need to place the most affected people by the change the center of attention. Empowering people to engage in the change will result in less resistance to the change and more resilience.

Table 10 User-centered change management gray literature

Author(s)	Year	Type	Title
Melissa Marsh and Mike Sayre [137]	2019	Magazine article	People-Centric Change Management
Ruth Williams [138]	2019	Blog post	Why Change Management Processes Need an Employee-Centric Approach
Laura Dietze [139]	2017	Blog post	Putting people front and center: user-centered change
Christian Lafrance [140]	2012	Slides	User centric change management

3.5. Chapter Summary

Healthcare organizations are making significant investments in CPOE systems in order to provide high-quality care and improve care efficiency. Organizations have realized that CPOE implementation projects are not just about installing new technology and then asking practitioners to use it; they represent massive transformation projects that change every aspect of the target organization. Organizations also realized that planning and managing the change is as important as choosing the most suitable CPOE system. According to Noteboom [3], the complexity of CPOE implementations is caused in part by the difficulty of managing the people's perspective, and 15% of the cost of such large projects is typically allocated for preparing users through training and change management.

One of the primary contributions to CPOE implementation success is the users' satisfaction and acceptance of the system. That satisfaction includes the users' involvement in understanding how CPOE systems are used and how the changes will affect their provided care.

After analyzing the barriers and facilitators that affect users' acceptance of CPOE systems, it is noticeable that most of the case studies have focused on physicians only and overlooked other clinician users of the system. While physicians are the primary users, nurses, pharmacists, and other clinicians are also using the system and their acceptance is also important. Moreover, even if the studies considered all potential clinician users and offered recommendations on how to gain their acceptance, they only offered very general points without further details on how to implement those recommendations as a complete plan for CPOE implementation.

Users' involvement during every step is a recurring recommendation, but most of the decisions regarding CPOE implementation are still made using a pure top-down approach, and it is not clear how organizations considered users' needs and opinions exactly.

Furthermore, it is evident that the lessons learned from CPOE implementation case studies are aligned with the change management principles that have been known in the business domain for decades. At the top of those principles comes effective users' involvement, suitable communication channels, and well-planned training programs.

Software designers have recognized the importance of involving users in the design process, and as a result the UCD approach was created. The UCD approach has been considered in some CPOE projects as a useful technique to incorporate when designing the CPOE system itself.

However, there is no evidence about using UCD during the design of the CPOE change management plan.

From the literature review, the gaps in CPOE implementation projects can be summarized as follows:

- **First**, despite the volume of published recommendations about what to do and what to avoid when implementing a CPOE system, healthcare organizations are having a hard time applying those recommendations. One reason can be that those recommendations are reported at a high level of abstraction with little guidance on how to translate and operationalize them into a detailed plan.
- **Second**, there is no explicit acknowledgment that users (i.e., practitioners) are the center of attention of the change and that their requirements must be collected and satisfied.
- **Third**, in most if not all cases, the clinicians' involvement is limited to the *design* phase of the system and does not include the *change management plan development*. In reality, clinicians' involvement in the change management phase is also important to create an appropriate environment for healthcare organizations to successfully implement CPOE systems and achieve a meaningful transition and use of the implemented systems.

In conclusion, there is a need for a detailed user-centered change management plan for a successful CPOE implementation. The change management literature is rich in well-known and well-tested models that can be used to achieve the desired outcomes.

Users' acceptance of CPOE systems required satisfying their needs and requirements. This chapter shed light on the factors that may affect users' acceptance and the possible approaches that can be used to achieve that required acceptance. Change management and UCD are known for their roles in managing and satisfying users. Through the literature investigation, it can be seen that combining both approaches can be the solution to advance CPOE implementation success and users' acceptance of such a system.

The next chapter will introduce a new process that combines UCD and change management in the context of CPOE implementation, in an attempt to fill the gaps identified in the literature and improve chances of success.

Chapter 4. Proposed UCCM Process

As previously noticed from the literature review in Chapter 3, clinicians' involvement during each step of the CPOE implementation is necessary for the success of the implementation and gaining the necessary acceptance of the system. However, this involvement should extend beyond *the system's design* phase to involve the *change management plan development*. Reviewing published work on the factors that contribute to clinicians' acceptance of CPOE systems has highlighted that most of the factors are, in fact, known principles in change management. Because clinicians are the center of attention of the change, the UCD approach is a suitable candidate approach to be combined with change management to improve CPOE implementation success and users' acceptance of such systems.

This chapter introduces a new *User-Centered Change Management* (UCCM) process that combines change management and UCD approaches to provide a detailed change management plan in order to prepare clinicians to change during the CPOE implementation. The UCCM process incorporates Kotter's change management model and the UCD approach.

This chapter gives an overview of the UCCM process and its components. It then presents a description of each of the UCCM process main steps.

4.1. Overview of the UCCM Process and its Basics

The User-Centered Change Management process guides healthcare organizations in preparing clinicians for upcoming changes that result from the installation of a CPOE system. The term *process* refers to a series of steps completed to achieve a particular goal. The UCCM process aims to enhance clinicians' acceptance of the CPOE system by making them the center of attention. The UCCM process comprises eleven steps resulting from combining change management (Kotter's model) and the user-centred design (UCD) approaches. The UCCM process provides ways to involve clinicians, mainly by considering their requirements, in the change management planning to improve their acceptance of the new CPOE system.

4.1.1 UCCM Process Objectives

To enhance users' acceptance of CPOE systems and achieve meaningful use of the implemented systems, the UCCM process is introduced with four primary objectives:

- Consider user requirements during change management plan development;
- Achieve users' acceptance of the CPOE system;
- Operationalize the change management plan to include a guide with clear steps on smoothly transitioning to the CPOE system; and
- Provide regular user engagement opportunities as the plan development and execution progresses.

The main target customers of the UCCM process are managers who are working with commercial (off-the-shelf) CPOE systems. In this case, managers may not have much control over the system design but still, control the implementation and change processes. However, managers who are working with homegrown CPOE systems can also benefit from the UCCM process. The difference here is that they can ask the design team to make changes based on users needs and requirements if needed.

4.1.2 Basic Concepts

The UCCM process has been built based on a list of concepts retrieved from the literature and discussions with experts in the field.

- **Change brings fear.** Users feel comfortable with the current situation even if it is problematic, because of the uncertainty that comes with change. They fear to lose their job or social position or even to fail to use the new technology properly [141], [117].
- **Poor change management affects users' adoption of technology.** That is because organizations focus their attention on technology implementation rather than on people who will use the technology [19].
- **The success of CPOE system implementation not only relies on the CPOE product but also on the process of implementation** [142]**.**
- **The success of any change initiative depends on properly managing the people side of the change** [141]**.**

- **Users' acceptance is a crucial success factor for CPOE:** If users do not use the CPOE system or underutilize it, the expected benefits will not be achieved [18], [143], [144].
- **Users' engagement is significant in CPOE acceptance:** Users' involvement and engagement in every step related to CPOE implementation are one of the essential factors in clinicians' acceptance of the CPOE system [7], [23], [105]–[107], [109], [111]–[115], [117]–[120].
- **Perceived benefits lead to acceptance:** Users' perception of the CPOE system has a strong effect on future use and acceptance of the system [11], [23], [106]–[108].
- **Training is an essential factor in CPOE success:** Without proper training, users will not be able to use the system properly, which may lower their confidence and lead to refusing to use the system [13], [107], [118].

4.2. UCCM Process Components

Clinicians represent a crucial factor of CPOE implementation success; without clinicians' acceptance, a CPOE system will not achieve its intended goals. Consequently, healthcare organizations need to adopt a user-centered approach when developing a change management plan for CPOE implementation.

This thesis combines change management models and the user-centered design approach to form the UCCM process by following these three steps:

1. Choosing the most appropriate change management model for CPOE implementation.
2. Choosing the most appropriate UCD approach for CPOE implementation.
3. Combining both approaches and filling the gaps between them, based on the users' acceptance factors from section 3.2, to develop the UCCM process as shown in Table 11.

4.2.1 Change Management Approach

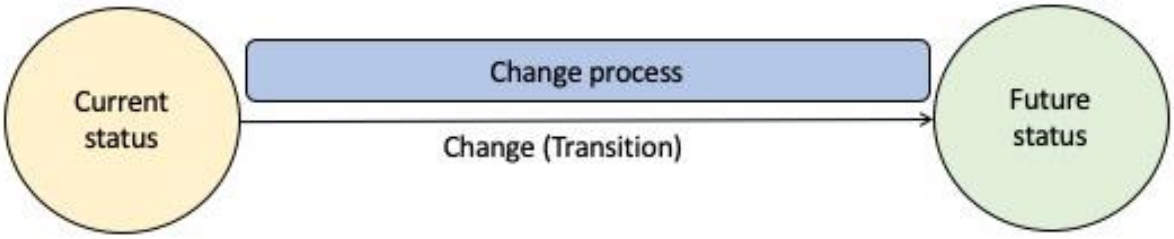

Figure 22 Transition process

The process of CPOE implementation in any healthcare organization involves a transition from one state (current state, e.g., paper-based orders) to another state (future state, e.g., CPOE orders). During this transition, the organization needs a roadmap to complete this transition/change (Figure 22) smoothly. Hence, the first component of the UCCM process is a change management approach.

The change management literature is rich in theories and models. After an extensive literature review of different models, the decision was made to use Kotter's change model [69]. Kotter's model is a structured model that considers both emotional and situational components in change [76] and promotes employee engagement in change initiatives. In addition, this model is relatively easy to understand and follow. It prepares users for accepting change by paying more attention to the human dimension and focuses more on the social process of change than other models. Furthermore, Kotter's model is adaptable to different organizational structures, and it recognizes the need to incorporate opinions from various stakeholders. Finally, and importantly, it focuses on users' involvement as an essential part of any change plan. Moreover, the CPOE implementation project is a large-scale transformation change that changes the culture of the healthcare organization. It requires a radical change in the way care is provided and in the way clinicians work. Kotter's model aligns more with larger-scale changes that would impact a large number of people [71]. For more details about the different change management models considered, see Section 2.3.2.

Kotter's model introduces an 8-step process for leading change, as presented in [69].

1. Establishing a sense of urgency

- Examining market and competitive realities.
- Identifying and discussing crises, potential crises, or opportunities.

2. Forming a powerful coalition
    - Assembling a group with enough power to lead the change effort.
    - Encouraging the group to work together as a team.
3. Creating a vision
    - Creating a vision to help direct the change effort.
    - Developing strategies for achieving that vision.
4. Communicating the vision
    - Using every vehicle possible to communicate the new vision and strategies.
    - Teaching new behaviours and leading by the example of the guiding coalition.
5. Empowering others to act on the vision
    - Getting rid of obstacles to change.
    - Changing systems or structures that seriously undermine the vision.
    - Encouraging risk-taking and non-traditional ideas, activities, and actions.
6. Planning for and creating short-term wins
    - Planning for visible performance improvements.
    - Creating those improvements.
    - Recognizing and rewarding employees involved in these improvements.
7. Consolidating improvements and producing still more change
    - Using increased credibility to change systems, structures and policies that do not fit the vision.
    - Hiring, promoting, and developing employees who can implement the vision.
    - Reinvigorating the processes with new projects, themes, and change agents.
8. Institutionalizing new approaches
    - Articulating the connections between new behaviours and corporate successes.
    - Developing the means to ensure leadership development and succession.

4.2.2 UCD Approach

Planning for change is the first step towards a successful CPOE implementation. In most cases, managers who are not always aware of clinicians' environment and requirements are responsible for developing change management plans. However, clinicians are the population most affected by the proposed changes, and their needs must be considered when planning for any change. For that reason, the second component of the UCCM process is inspired by the UCD approach. Clinicians' needs, requirements, and limitations must be considered at each stage of the change in order to gain their acceptance of the CPOE system. In the UCCM process, the UCD approach is used to design the change management plan and not the CPOE system itself (which is most often bought off the shelf).

UCD was initially proposed to ensure that any designed system is efficient, effective, and satisfactory to the end-users. There are many variations of the UCD process. For the UCCM process, the decision here is to combine the UCD models from the Web Accessibility Initiative [95] and the US Department of Health and Human Services [96]. This combination will help ensure sufficient coverage of the necessary UCD steps in a way that is aligned with Kotter's model, as follow:

1. **Identify the problem:** Describe the system to be designed.
2. **Specify the context of use:** Identify the environment and users in which the system is being used.
3. **Specify requirements:** Identify any requirements and limitations that can affect design success.
4. **Create design solutions and development:** Move from concept to complete design.
5. **Evaluate product:** Test the design with actual users.
6. **Iterative design:** Update the design based on the evaluation results.

The main goal of UCD is to facilitate human-computer interaction [21] by focusing on the design's usability and involving users in the system's design. However, the UCCM process adopted UCD and used its principles to design the CPOE implementation change management plan to make clinicians the center of the plan.

Table 11 Mapping Kotter's model and UCD to the UCCM process

Kotter's model	UCD	UCCM
• Establishing a sense of urgency	• Identify the problem	**S1.** Building motivation to change
• Forming a powerful coalition		**S2.** Forming a Change Committee
• Creating a vision		**S3.** Creating a vision
	• Understand context, tasks, and users	**S4.** Analyzing context and workflow
		S5. Choosing champions and superusers
	• Specify requirements	**S6.** Analyzing and identifying users and their requirements **S7.** Considering previous experiences
• Communicating the vision • Planning for and creating short-term wins • Empowering others to act on the vision	• Create design	**S8.** Developing the change management plan **S8.1** Goals, approach, and timeline **S8.2** Workflow optimization plan **S8.3** Resistance plan **S8.4** Leadership engagement plan **S8.5** Measures plan **S8.6** Short-term wins, rewards, and recognition plan **S8.7** Training plan **S8.8** Communication plan **S8.9** Support plan
	• Evaluate and improve design	**S9.** Evaluating the change plan
• Consolidating improvements and producing still more change	• Evaluate and enhance system • Identify future needs	**S10.** Monitoring and evaluation
• Institutionalizing new approaches		**S11.** Providing ongoing support

4.3. CPOE System Implementation Phases

Before digging into the actual UCCM process steps, it is worth mentioning where and why the UCCM process fits in the CPOE lifecycle.

The CPOE literature has different definitions of the CPOE system implementation lifecycle/stages/phases. However, for this research, I adopted a simple definition that divides the CPOE system implementation into three phases (Figure 23): pre-implementation, implementation, and post-implementation.

- **Pre-implementation:** This is the period where the planning and preparation are done before the system gets deployed. This is also where most of the UCCM process steps are performed.
- **Implementation:** This is where the actual system is deployed and where the users can see real changes to work processes. This phase is also called *the shakedown* period [16].
- **Post-implementation:** This is where stability is expected after the system deployment—typically, about six months after the implementation [16], [145].

The first nine steps of the UCCM process are completed during the pre-implementation phase, while the last two steps are done in the post-implementation phase.

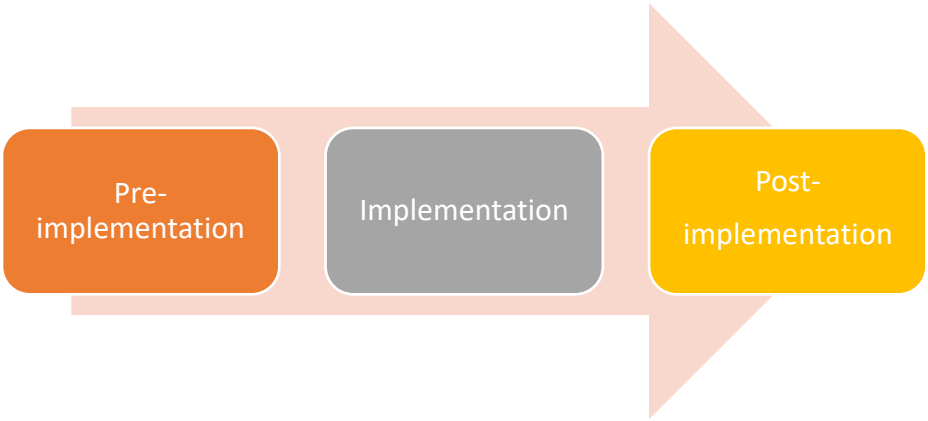

Figure 23 CPOE implementation phases

4.4. Users' Involvement/Engagement in the UCCM Process

The UCCM process aims to make CPOE users the center of the change by adopting UCD principles. To achieve this goal, the UCCM process needs to:

1. Achieve the buy-in of users by listening to their needs and communicating clearly with them;
2. Actively involve the users in the development of the change plan; and
3. Incorporate their needs and desires as much as possible when developing the change plan.

Users' involvement/engagement in the UCCM process can be either direct or indirect. *Direct* involvement is when most users are involved personally by answering questionnaires or participating in interviews. *Indirect* involvement is when users' representatives are sharing ideas on behalf of the real users.

Ensuring the users involvement in each of the UCCM process steps, specifically through the change committee, provides a way to evaluate and adjust the change plan as it is developed, i.e., using continuous validation. That will help spot and address important issues before it is too late and costly to do so.

When defining the UCCM process steps, users' involvement/engagement will be stated for each step.

4.5. Suggested Tools and Methods

In most of the UCCM process steps, a list of tools and methods is provided. The goal of the list is to give decision-makers an example of the available mechanisms to execute the step. Table 12 summarizes the suggested tools and methods per steps. It is noticeable from the table that most of the presented tools and methods are adopted from the UCD approach. Table 5 (from Chapter 2) presents a set of frequently used UCD methods along with their purposes. Interviews and questionnaires are the most suggested methods because they elicitate data directly from the target population.

Each one of these mechanisms has its pros and cons that must be considered when deciding which one to apply. Information on methods advantages and disadvantages is available in [146], [147]. Moreover, choosing the best-fit method requires considering

many factors, such as the cost-benefit ratio of applying the methods [89], the level of intrusiveness, resource and time constraints, and the immediacy of responses [94]. The change committee is responsible for deciding which mechanism or mix of mechanisms is best for their organization.

Table 12 Summary of suggested tools and methods for the UCCM process steps

Step	Tools and methods
Building motivation to change	• Interviews or questionnaires • Change readiness assessment • Reports on organizational performance • Brainstorming sessions and focus groups • Observations and field studies • Process analysis • Clinical use cases and scenarios
Forming a Change Committee	• Responsibility assignment matrix (RACI) • Team management tools
Creating a vision	• Brainstorming sessions and focus groups • Observations and field studies • Process analysis • Clinical use cases and scenarios
Analyzing context and workflow	• Activity based Process Integration (AbPI) framework • Clinicians working groups • Observations and field studies • Interviews or questionnaires • Process analysis • Clinical use cases and scenarios
Analyzing and identifying users and their requirements	• User Requirements Survey* • Stakeholder mapping • Interviews or questionnaires • Delphi approach • Focus groups
Considering previous experiences	• Reports on projects progress and outcome • Academic publications
Evaluating the change plan	• Interviews • Presentation followed by a Q&A session
Monitoring and evaluation	• User Satisfaction Survey* • Interviews or questionnaires

* Surveys were developed in this thesis and are ready to be used.

4.6. UCCM Process Steps

Implementing a CPOE system brings many benefits to healthcare organizations, patients, clinicians, and healthcare systems in general. Nevertheless, such implementation is exceptionally complicated and involves many challenges. A CPOE system implementation causes an enormous change in the way people work and on existing clinical and business processes by affecting workflows, policies, procedures, and healthcare models. Such changes can increase the level of resistance among clinicians who can delay the CPOE implementation project, if not cause it to fail.

Clinicians' acceptance of the CPOE system is an important predictor of its success and a significant challenge as well. Resistance can be a danger for CPOE implementation because clinicians can create workarounds or openly resist using the system altogether. Many reasons can cause clinicians' resistance, such as:

1. Uncertainty about how the change will affect their current situation;
2. Fear of loss (job, role, power, or social position);
3. Concerns about patient safety; or
4. Fear of not having the required skills to succeed with the new technology.

Because change is unavoidable, despite all the challenges that accompany it, the goal here is to create a change management plan that prepares clinicians to change and gains their acceptance with a minimum level of disruption. The UCCM eleven-steps process is introduced to work towards this goal by making clinicians the center of the change. Figure 24 presents the UCCM process with respect to Lewin's 3-step change management model [70] as it is considered the base of change management models.

The following section explains each of the UCCM process steps, their goals, how to execute them, and who the actors are. Table 13 is a summary of the UCCM process steps.

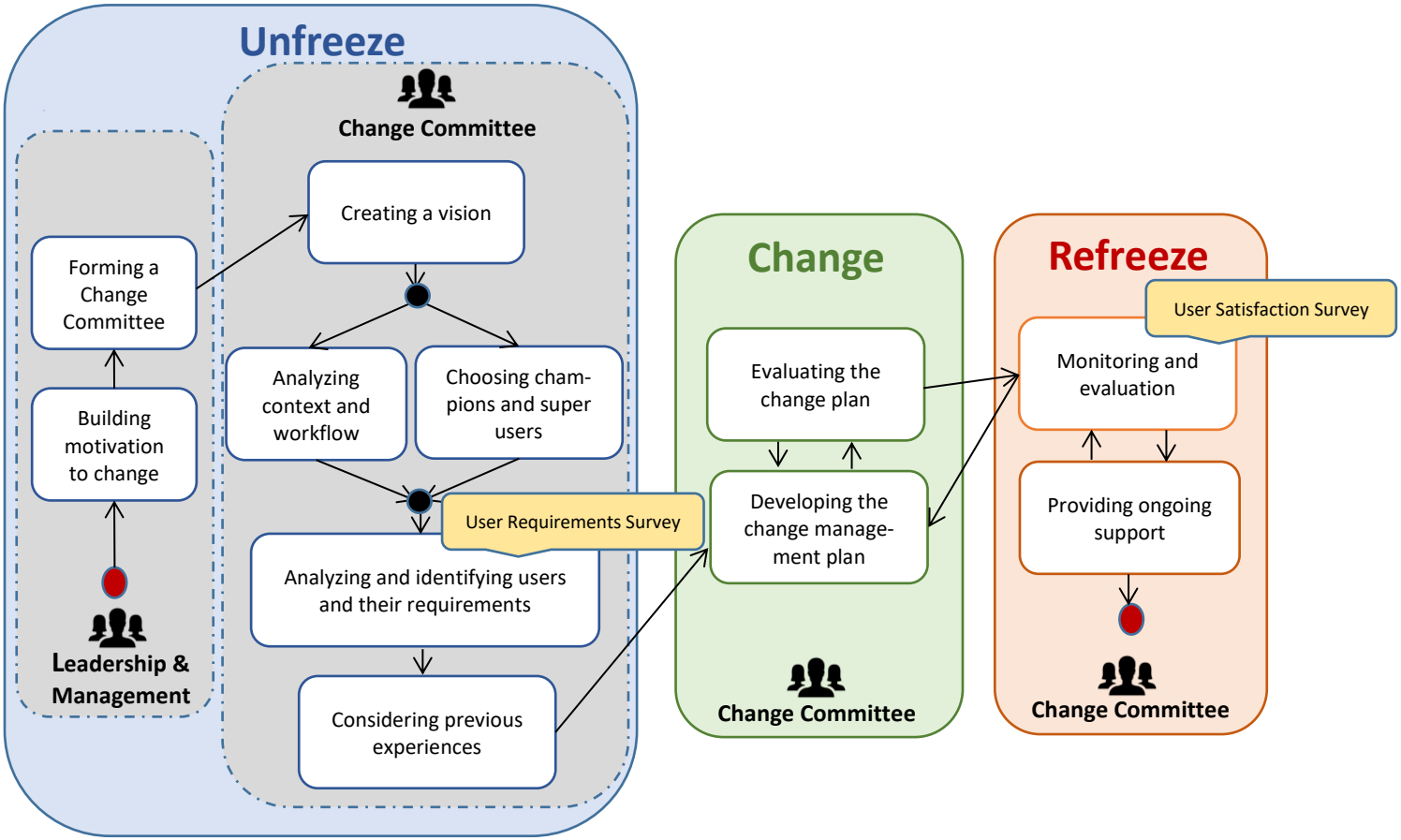

Figure 24 The UCCM process

S1. Building motivation to change

Building motivation to change is the first step in gaining the acceptance of clinicians. In the UCCM process, building motivation goes through two main stages: building a case for change and engaging leadership.

In order to accept the CPOE system, clinicians need to realize the value and benefits of the system. Building the case for change starts by answering the question, "*why do we need/have to change the current status, at this time?*". This step aims to create readiness for change by identifying why the change needs to occur and describing how the future state will look like. To gain clinicians' acceptance, clinicians must understand why the CPOE system is needed, what the goals of the CPOE implementation are, how the future status will look, what are the expected benefits and value, what is the cost of not implementing the system, and importantly, what is in it for them.

The motivations of users have different shapes and forms. Some users are motivated by issues related to patient safety, while others are more motivated by their own gains or losses. Considering as much of the promising motivations as possible is a must to reach a consensus on the change significance.

Accordingly, identifying the motivation should include patient care/safety, healthcare organization, and clinicians affected by the CPOE system implementation. There may be some redundancy/overlapping between the motivations, but it is necessary to cover as many as possible. See Section 2.1.4 for more information about the CPOE system's benefits.

1. Patient care/safety motivation
    a. Standardizing the documentation.
    b. Reducing medication errors.
    c. Reducing turnaround time.
2. Organization motivation
    a. Identifying the reasons behind the change.
    b. Identifying the problems with the current status.
    c. Identifying the future status.
    d. Identifying the differences between the current and future statuses.

3. Clinicians motivation
    a. Reviewing potential reasons for dissatisfaction with the current status.
    b. Explaining how their work will be affected by the new system.
    c. Presenting the relevant benefits of the new system.
    d. Addressing their fear, concerns, and expectations.
    e. Identifying possible disadvantages to clinicians and ways to mitigate those disadvantages.

At this stage, it is the leadership and management's duty to build the case for change and need for the CPOE system.

The second phase of building motivation to change is getting leadership engagement. Transitioning from a paper-based system to a CPOE system requires buy-in from the senior executive team, first from the CEO and then from the rest of the organization. Creating *motivation* and identifying reasons for CPOE implementation alone are not enough. Leadership engagement and support of the implementation are a must for the sake of success. According to Kotter's model [69], at least 75% of an organization's management must be convinced that the current state should change; otherwise, change efforts can suffer from serious issues later.

Leadership engagement and complete support for the change objectives and activities are essential not only in the implementation success but also in enhancing clinicians' acceptance of the CPOE system. Leadership engagement is crucial for building trust and boosting clinicians' engagement.

Tools and methods

Building a change case to motivate clinicians can be done using several tools and methods. Most of the tools are adopted from the UCD approach.

- Interviews or questionnaires with target populations (leadership, clinicians, and others);
- Change readiness assessment;
- Reports on organizational performance;
- Brainstorming sessions and focus groups;
- Observations and field studies;

- Process analysis; and
- Clinical use cases and scenarios.

S2. Forming a change committee

At this point, the change process requires leadership to continue planning for the change. It is essential to form a team/committee of key employees to lead the change. The goals of creating the change committee are to:

- Have key staff who will lead the change;
- Provide an early and continual focus and support on users; and
- Actively involve users in the decision-making process.

A *change committee* is a group of individuals with enough decision power to lead the change [69]. The involved individuals should work together to plan for the change and address emotional and situational challenges [141] during the CPOE implementation process. The committee should involve members with different titles, expertise, and relationships with the rest of the organization to gain credibility. It should have members with clinical knowledge and understanding of technology's effect on clinicians, healthcare systems, and care processes, as well as working knowledge of change management and project management [19].

For the CPOE system implementation, the change committee should involve senior management members to gain the necessary power and show leadership engagement. It should also include board members and representatives for every potential user group, such as physicians, nurses, pharmacists, other allied health professionals, and IT members. Clinicians members should represent varying levels of specialties and seniority. In summary, the committee should have a maximum variation of members to represent a broad range of perspectives. The number of clinician representatives should outnumber other representatives to make the change more user centered. All roles and responsibilities of members must be defined and agreed on. Moreover, expectations from each member must be clarified.

Besides, healthcare governance differs from one country to the other. Hence, it is important to consider this difference when forming the committee. For example, in Canada,

nurse unions are quite strong; therefore, union representatives could be involved in the change committee.

Because of its importance in carrying out the change, change committee members must be chosen carefully by the leadership and management. The committee should have members who:

- Understand the goal of this change and how implementing the new CPOE system will improve care quality.
- Believe in the organization's vision for the future state after implementing the CPOE system.
- Are enthusiastic about working towards achieving the final goal.
- Understand why change needs to happen at this time, and then communicate that clearly to stakeholders.
- Are aware of the current status with all its workflows and processes.
- Are equipped with the necessary people management skills, if possible, in order to be able to address both the emotional and situational challenges that will occur throughout the change process [141].

In large healthcare organizations, the change committee can be divided into other sub-committees for different units or wards. So, each sub-committee provides input from its department. That makes it easier for the change committee to arrange questions and answers sessions or focus groups with users. Note that the change committee could be integrated with the project committee.

The committee should arrange periodic meetings based on its members' availability to keep updated with user requests and problems encountered with CPOE and to continue improving the system.

Users' involvement in this step is indirect through their representatives on the committee.

Tools and methods

Forming and managing the change committee can be done using:

- Responsibility assignment matrix (RACI) [148], [149]; and
- Team management tools.

S3. Creating a vision

After establishing the urgency to change and forming the change committee, it is time to define a roadmap to direct the change effort within a specific timeframe. With a considerable amount of procedures, goals, methods, and deadlines, stakeholders and decision-makers could lose their sense of direction and motivation. The change committee hence needs to craft the *change vision*. The goal of this vision is to guide the healthcare organization during the change journey and drive its objectives. By presenting a picture of how the future status will look after the change, stakeholders will be motivated to achieve the change goals. In order for the vision to achieve its intended purpose, it should be:

- Motivational enough to inspire both those who are convinced by the change and those who are not.
- Simple, memorable, and yet general enough to capture the interests of the organization and stakeholders. In Kotter's words [69]:
  "… if you can't communicate the vision to someone in five minutes or less and get a reaction that signifies both understanding and interest, you are not yet done with this phase of the transformation process."
- Accompanied by a defined time in the future when it will be achieved and evaluated.
- Feasible in terms of available budget, resources, and time.

The users' engagement in this step is achieved indirectly through their representatives in the change committee. The representatives must communicate the users' goals and feelings toward the change when creating the vision.

Tools and methods

For creating the vision, most of the tools used in the first step can be reused to help the change committee create the vision, including:

- Brainstorming sessions and focus groups;
- Observations and field studies;
- Process analysis; and
- Clinical use cases and scenarios;

S4. Analyzing context and workflow tasks

CPOE system implementation differs from one organization to another due to variability in capacity, resources, and budget. Based on those differences, decision-makers must consider identifying what resources are available and which ones are not, how large the available budget is, who the primary users are, and under what conditions they will be using the system. For example, are clinicians going to use the CPOE system in the emergency room, the outpatient clinics, or both?

This step aims to acquire a comprehensive understanding of the tasks, work context, changes to the work, and user interactions with the CPOE system. Collecting the required data from a contextual investigation is necessary to plan for the change in the next steps.

Each unit in the organization is unique with its work processes, users, and resources. Different types of units provide different types of care and services for patients. For example, there are significant differences between the acuity of care between the emergency department and rehabilitation. There are also differences in resources such as the number of available computers, as well as the shifts and system needs during evenings and weekend hours [150]. All those factors need to be considered when planning for the change.

Context analysis

This analysis describes the nature or features of the organizational, technical, and physical contexts in which the CPOE system will be implemented. The purpose of the context analysis is to ensure that users have the required infrastructure and resources to use the system as intended. Besides, understanding the organizational culture facilitates defining user behaviour. Understanding context factors will not only affect how the change will be planned but will also affect users' attitudes toward the CPOE system.

Context analysis is not complete without analyzing each department's work context and the different goals of each department and its clinicians. Also, this analysis must include a description of the processes needed to achieve those goals.

Workflow analysis

Examining the workflows before the CPOE implementation is an essential step. Implementing the CPOE system will impose new processes to the clinical workflow. Embedding

those processes into the clinical setting requires a thorough analysis of the current workflow. Additionally, workflow analysis identifies areas for improvement, further opportunities for progress, such as bottlenecks and redundant processes.

From the change management perspective, workflow analysis helps decision-makers (change committee) planning for the change management plan. It helps them understand how the CPOE system can impact workflow and clinicians. Such understanding is essential for planning for other aspects of the change, such as short-term wins, further opportunities for change, communication, and training [19].

Undoubtably, identifying and analyzing contexts and workflows is not an easy mission. This step requires much planning, time, and resources. However, the cost of neglecting this step could be higher.

Users' involvement in this step is indirect in the form of their representative in the change committee who make users the center when considering the context and tasks. Another possible way of involving users, directly this time, is by creating working groups that involve clinicians. Such groups would aim to analyze workflows in their department and report the result to the change committee.

Tools and methods

- Activity based Process Integration (AbPI) framework [151], [152];
- Clinicians working groups;
- Observations and field studies;
- Interviews or questionnaires;
- Process analysis; and
- Clinical use cases and scenarios;

S5. Choosing champions and superusers

In addition to the change committee, other teams of employees, namely champions and superusers, have an essential role in the UCCM process. Those teams can be part of the change committee as well. The goal of having champions and superusers is to engage and support users during the CPOE system implementation.

Appointing system champions and superusers can be done either before or after the *analyzing context and workflow* step. The preference is to choose them after the analysis to enable taking the collected information into consideration.

Champions

A champion is a staff who is supportive of the change and can keep the implementation process moving forward [141]. A CPOE change project can have a single champion or a group of champions, depending on the organization size and the number of employees. A champion can be a physician, a nurse leader, or a representative from the administrative staff or clinical staff. The essential idea is that the champion is *trusted* among their peers and is a true believer in the CPOE system. According to Saathoff [153], a physician champion has a significant influence on the CPOE acceptance of other physicians because the latter more easily trust information provided by physicians and because physician champions can oversee clinical aspects of the implementation in addition to administrative aspects.

On the other hand, Jones and Moss [13] claim that nurses make good champions because they understand physician workflows. They can help physicians realize the benefits of adopting the CPOE system in their practice. When considering a group of champions, it is good to include champions from various departments and specialties.

The champion plays a vital role in building trust between users and the CPOE system. S/he is the advocator for CPOE adoption and the communication vehicle between users and the change committee. S/he recognizes CPOE adoption challenges and obstacles and communicates them with the change committee for improvements [7]. It is her/his responsibility to communicate with the clinicians to understand their requirements, address their needs and concerns, and update them with any changes to the project.

To benefit the most from a champion, the selected champion should have the following characteristics (adapted from [7]):

- Have a full understanding of the goal and urgency of the change;
- Be convinced of the CPOE benefits;
- Be knowledgeable of different processes and workflows that will be affected by the change;
- Recognize the power of involving clinician opinions in the plan;
- Be respected by her peers in order to win their attention;

- Be a strong supporter of the CPOE implementation;
- Preferably be a clinician; and
- Be energetic and easy to collaborate with.

Superusers

A superuser is a user, mostly nurses or unit clerks [7], who is specially trained to provide at the elbow support to other users when they are struggling to use the CPOE system. Superusers are crucial for intensive support (24/7) during the initial CPOE launch and the following first weeks after go-live. Superusers learn the system inside out and are able to answer clinicians' questions on how to use the system. They will also be responsible for teaching new users how to navigate the system. It is best to appoint superusers for each department and provide them with extensive training on the CPOE system to provide on-the-unit support for other users. Another critical role for superusers is providing feedback on training materials because they are trained before the rest of the users.

It must be pointed out here that encouraging employees to be part of the change team and take on this extra responsibility requires offering incentives and compensation for their time and effort. This also requires releasing them from patient care duties temporarily.

Users' involvement in this step is indirect in the form of their representative in the change committee.

S6. Analyzing and identifying users and their requirements

Before moving forward and developing the change management plan, one more step to do is *analyzing and identifying users and their requirements*. User analysis is about identifying target users and describing their characteristics that may affect their acceptance and usage of the system. To empower users to be more effective and efficient in using the CPOE system and deliver quality care to patients, their roles, work practices, computer experience, expectations, concerns, and requirements must be assessed before moving ahead with the change. There is no one-size-fits-all approach here. A healthcare organization involves a broad range of clinicians in different departments with different specialties and different characteristics and requirements. In addition, clinicians' relationships with the organization vary, e.g., residents, interns, and attendings. As a result of this variation

in roles and specialties, it is crucial to collect data about those different clinicians to make clinicians the center of attention in the CPOE implementation plan.

When designing a specific system, it is vital to consider its users' characteristics and tailor that system based on those characteristics. The same thing is applied when creating the change management plan for the CPOE system implementation. Understanding users who will be affected by the change will help discover what motivates them to use the CPOE system and understand the source of their resistance toward accepting it. Besides, this step contributes to establishing realistic expectations from the management about the users and from the users about the CPOE system. For example, one of the main challenges faced by healthcare organizations during CPOE implementation, specifically in small and rural hospitals, is the amount of clinician turnover. This turnover produces two types of CPOE system users: new and infrequent users. Hence, organizations must plan how to train those users while considering whether they have been exposed to the CPOE system before or not.

Moreover, it is more challenging to deal with infrequent users. The challenge is that they may be exposed to different CPOE systems with different functionalities, making it hard for them to remember how each system works. The work of Gellert et al. [104] suggests a few solutions, including having basic cheat sheets to walk infrequent users through the typical process they are expected to perform or designating a staff member (e.g., a superuser) to always be ready to assist them.

For the healthcare organization to be able to detect and deal with the above example, analyzing and identifying users and their requirements is key. The final product of this analysis will be a comprehensive understanding of the users and their expectations, concerns, and requirements.

While this step could be divided into two sub-steps, analyzing users and identifying user requirements, I found it is best to combine them in one step because there is much overlap between users' characteristics and requirements. Besides, surveys, interviews, Delphi, and focus groups are examples of the tools that can be used in both steps. So, to save time and costs, combining both steps represents a good option.

Understanding the attitudes of future users is essential in improving their final acceptance of the CPOE system. For that reason, the UCCM process includes *three elements*

of user analysis: users' inventory information; users' perceptions, concerns, and expectations; and users' requirements.

User analysis elements

1) Users' inventory information: The goal of this inventory is to address the specialty-specific needs of the users during the CPOE implementation. The inventory includes counting the number of clinicians who will be using the CPOE system, and their different specialties, roles, skills, experiences with computers and CPOE systems, years of experience, and relationships with the organization.

According to previous researches [154], [155], demographic characteristics may affect the user's willingness to accept or reject information systems. Hence, obtaining such information is necessary for developing the CPOE implementation change management plan to enhance clinicians' acceptance of the system.

2) Users' perceptions, concerns, and expectations: To develop a better understanding of the factors that can either enhance or hinder the users' acceptance of the CPOE system, it is crucial to examine their perceptions, concerns, and expectations regarding the CPOE system before implementing the system in their organizations. This understanding is essential to develop an effective change management plan that can ease users' transition after go-live.

As mentioned before in the first step, motivations and concerns vary among users, so understanding what motivates and concerns users helps decision-makers later on when creating the communication plan by emphasizing what motivates and concerns users.

In addition, users' perceptions surrounding individual and safety benefits influence their satisfaction with the CPOE system [154]. The same concept can be applied when developing a change management plan. Understanding users' expectations regarding the CPOE system and the change accompanying it plays an essential role in obtaining the buy-in of users.

Another essential element is to understand users' expectations when implementing the CPOE system. It is essential to appropriately manage expectations so that users will not be disappointed by the reality. For example, the workload and time required to accomplish some routine tasks may likely increase after introducing the CPOE system. Users must

hence have reasonable expectations before the system goes live. Examining users' initial expectations is necessary to set the correct expectations regarding how the CPOE system will influence their work routine. This will in turn improve the likelihood of their acceptance of the system.

3) Users' requirements: The participation of clinicians in developing the change management plan of the CPOE system is crucial because it 1) promotes having multiple viewpoints, 2) considers clinician-related aspects, and 3) helps develop a tailored change plan.

In addition to analyzing the users and understanding their perceptions, it is essential to ask them directly about their needs and requirements for planning the change. Collecting the requirements is necessary not only for the users' satisfaction but also for the CPOE system implementation success. Besides all the analysis that has been done in prior steps, users' requirements assist the change committee in planning for budget, implementation schedule, quality specifications, risks, and resources.

Analyzing and identifying users and their requirements can be done using surveys, interviews, and/or focus groups. The change committee is responsible for deciding which mechanism or a mix of mechanisms is best for their organization. However, the UCCM process proposes the use of a cross-sectional survey. Because such surveys help estimate specific parameters in a population at a single point of time [156]. It is also better when soliciting input from a broad range of clinicians in a short time, asynchronously, from different locations. The survey could be supplemented by interviews later to confirm the results.

Tools and methods

Several tools can be used to analyze users, such as stakeholder mapping, surveys, interviews, Delphi, and focus groups. This section describes a *pre-implementation user requirements survey* that is part of the UCCM process. It can be used to analyze users and their requirements.

The core step of the UCCM process is the *analyzing and identifying users and their requirements* step. This step is where users are involved directly in the process and share their opinions and ideas about the change, and it is the main foundation for building trust between the organization and the users.

I have developed a survey called "User requirements survey" to analyze and identify users and their requirements in this step of the UCCM process. Although the survey collects information about users' expectations and perceptions and not only requirements, I called it user requirements survey to make it easier for the users to understand its purpose.

This survey aims to explore clinicians' requirements, characteristics, and preferences prior to the CPOE system implementation. The survey results will help the change committee highlight different requirements, concerns, expectations, and unseen issues associated with some aspects of the CPOE system implementation. It will also help increase the clinicians' acceptance of the system by 1) demonstrating to the users that the management is actively listening to their concerns, and 2) using the results to create suitable CPOE change management plans, including communication and training plans.

The survey collects information about users' skills and experience with computers and CPOE systems, roles in the organization, years of experience, relation with the organization, expectation from the CPOE system, any special requirements to accommodate clinicians with special needs, possible barriers, training method preferences, and communication channel preferences.

The proposed questions were developed after reviewing the literature. I also validated the questions with a group of domain experts, including clinicians and members of the CPOE implementation committee of Ontario's CHAMPS[1], and incorporated their feedback. Additionally, the survey was deployed as a pilot in a hospital.

The response format of the survey questionnaire comprises different forms including Likert scales (Excellent, Good, Average, Poor, Very Poor) and (Strongly agree, Moderately agree, Strongly disagree, Moderately disagree, Not sure, Not Applicable), multi-option, fill-in-the-blank, and unstructured responses (for open-ended questions). The survey contains 34 questions distributed over four sections (see Appendix A for more details about the survey questions):

1. **Demographic information:** This section aims to collect demographic information that may affect clinicians' willingness to use the CPOE system. It can also be used to spot possible patterns of requirements based on demographics.

[1] https://www.champlainhealthline.ca/

2. **Self-reported computing and CPOE experience**: This section aims to gather information regarding clinicians' previous experience with computers and CPOE systems to develop the training plan and determine the required intensity of training and if there is any need for basic training in computer usage. It is also essential to determine each user's role in using the CPOE system to avoid training them on unnecessary system functions. Frequent and infrequent users should be identified so UCCM can plan appropriately for them in advance. The gathered information will also help in planning for a refresher and pretraining before the CPOE training.
3. **Preferences and requirements**: The goal of this section is to determine clinicians' preferred style and amount of training, communication, and support channels desired during the CPOE implementation.
4. **Expectations and engagement:** This section aims to measure clinicians' willingness to use the system and identify potential hinders and facilitators to CPOE acceptance in clinicians' opinions. It also aims to 1) indicate whether clinicians believe that the CPOE would benefit them and their organizations, and 2) the clinicians' feelings towards being involved during the plan development phase.

The survey findings aim to help address the needs of each specific user group and ensure that the change management plan will assist them in their transition journey. However, those findings should be examined for alignment with the change's visions, the CPOE implementation project, and the organization.

S7. Considering previous experiences

There is a high probability that the CPOE system implementation is not the first transformational project that the organization experience. Additionally, organizations that undergo similar projects face similar issues. Lessons learned from previous projects (either by the same organization or peer organizations) are a gem. The change committee can learn a lot from those experiences by:

- Identifying and avoiding issues experienced by previous projects.
- Identifying requirements.
- Incorporating best practices from previous projects.

Tools and methods

- Reports on projects progress and outcome; and
- Academic publications.

S8. Developing the change management plan

After identifying the change committee, context, and requirements, it is time to develop the change management plan using the collected data. Incorporating users' preferences in the plan creates value for users and gives them a sense of ownership of the plan and the CPOE system.

The plan is divided into *nine sub-plans* to cover a wide range of change aspects.

S8.1 Goals, approach, and timeline

The first step in developing the change management plan is to define the intended goals of the implementation. This definition will help later when deciding the implementation approach and timeline.

Besides the CPOE system's overall goals, the change committee needs to agree on the implementation goals, such as deadlines, future statuses, and which departments will be affected.

Based on those goals and the information collected from the analyses done in the previous steps, the change committee can decide how and when to implement the CPOE system. This implementation can be done in many ways (from [157]):

1. The *big bang* implementation, in which the entire organization goes live on CPOE all at once;
2. The *rapid rollout* implementation, in which CPOE is brought live one unit/department at a time, at a relatively fast pace; or
3. The *incremental/staged* implementation, in which CPOE is deployed in small stages, one at a time, which can be placed at whatever pace the organization is comfortable with.

Each of the above approaches has its advantages and disadvantages. For example, the big bang implementation could work best in smaller organizations because the disruption is vast. Meanwhile, the incremental/staged approach makes it easier for organizations to manage the disruption to work by delivering it in incremental progress, which makes more

sense both practically and financially. It also allows enough time for users to develop the required skills for using the system and to adapt to the changes. However, the incremental/staged approach takes longer than the big bang approach and possibly requires legacy and new systems to coexist. The same observations apply to the rapid rollout approach, with slightly different risks.

After deciding which approach to choose for the CPOE system implementation, the timeline should be developed by considering the information collected before and the time of the year, the workload, and the expected number of patients at the time of implementation.

The timeline importance comes from its potential impact on users. For example, unjustified delay in implementation may lead to a loss of interest and trust, which could cause further resistance.

S8.2 Workflow optimization plan

Based on the data retrieved from analyzing the current workflow and how it will be affected by the CPOE system implementation, a plan of how to optimize and integrate the new workflow is a must. The goal is to ensure the workflow performs as efficiently as possible after the introduction of the CPOE system functions. It is also an opportunity to review and improve the existing workflow and fix any related issues.

S8.3 Resistance plan

With the assistance of the champions and users' representatives, the sources of resistance can be identified, and a plan for addressing this resistance can be developed. For example, suppose the users showed hesitance in accepting the CPOE system because they are concerned about their typing speed. In that case, the change committee can add special training classes for typing or provide a list of resources on how to improve typing speed.

S8.4 Leadership engagement plan

"Nothing undermines change more than behaviour by important individuals that is inconsistent with their words." Kotter [69]. The importance of leadership engagement has been stated several times in the literature. Because of this importance, the leaders' activities to promote the change must be planned carefully.

Leadership engagement must be demonstrated clearly by both their words and behaviours every day to gain users' trust. As tennis champion Martina Navratilova said: "The difference between involvement and commitment is like ham and eggs. The chicken is involved; the pig is committed".

The leadership engagement plan can be a stand-alone plan, or it can be part of the communication plan that will be introduced later.

S8.5 Measures plan

Whether the organization decides to adopt the big bang implementation approach or any other one, the change committee should identify metrics and measures to track and assess the implementation processes' outcomes.

This plan aims to identify metrics and measures to evaluate the progress towards achieving the CPOE implementation goals, for example, measuring the CPOE system efficiency, clinicians' acceptance and satisfaction of the system, and its usefulness.

The measures plan is created to measure the impact of the CPOE implementation in the care process. In other words, to measure the system's success in delivering what is expected.

S8.6 Short-term wins, rewards, and recognition plan

Implementation can take time, and clinicians may lose motivation during this time. Planning for short-term wins in advance is an excellent practice to keep momentum [69].

The goal here is to have visible, meaningful, and attainable achievements that users can measure and take pride in achieving. Planning for those wins can be as simple as breaking down the implementation into a series of milestones. Besides planning for the wins, celebrating those wins should also be planned as appropriate.

During the change journey, there will be some individuals who will go the extra mile. Other times, one unit will outperform other units in adapting to the change, for example. All these efforts must be recognized and rewarded. Besides, users' representatives, champions, superusers, and other users involved in the implementation and change must also be recognized and rewarded publicly.

Therefore, to motivate users and demonstrate that they are appreciated, a plan for rewards and recognition must be developed. The incentives may be monetary or non-monetary. It depends on every organization's policy and budget.

S8.7 Training plan

Based on the data collected before, organizations can develop the best plan to train clinicians on how to use the system, while considering the different preferences, skills, and learning styles of different clinicians. The training plan includes two parts: one to train superusers and the other to train clinicians.

According to Rai et al. [16], clinicians who find the system easy to use are more likely to accept it and vice versa. Consequently, training must be planned wisely to help users learn the system and develop the required skills.

The training plan must be developed based on the information (context, and users' skills and experience) to meet the requirements. For example, training can be done on a one-on-one basis when turnover is low. In other organizations, where there are many students, for example, training needs to be done in groups and frequently held [29].

The practical training plan must consider:

- Using real-life scenarios as hands-on examples in training classes.
- Developing and improving training material iteratively based on superusers' feedback.
- Involving a clinical specialist in training classes to answer questions during training.
- Using a demonstration system "playground" (or "sandbox") that potential users can test before go-live to identify training needs early and encourage users to practice using the system. The playground version should be physically separated from the planned production system and located outside of clinical areas to be used in private settings. According to [158], projects using those playgrounds reported higher CPOE adoption rates.
- Considering users' preferences for the training style, time, duration, and amount of training while considering the training's available resources and budget.

Planning for training is not limited to training new users only; it also considers long-term training plan on how to train users on the new features and functionality that will be added later on.

S8.8 Communication plan

Creating the perfect system is not sufficient to get users' buy-in and acceptance. It is hard, if not impossible, to implement CPOE system successfully without the acceptance of a considerable number of users. There is an urgency to communicate the change's vision and goals with users in order to earn their trust and support for the change. Such communication requires using every channel possible to advocate for the change. According to Kotter [69], organizations have three patterns when it comes to failing at communication:

1. Holding a single meeting or sending out a single communication.
2. Seeing the organization leaders spend a substantial amount of time talking about the change and vision, without having employees being convinced.
3. Despite the amount of effort to communicate with employees, having some senior executives behave in ways that oppose what they promote.

To avoid the above mistakes and develop a good communication plan, that plan must be developed based on the information retrieved from analyzing the users and the context where the CPOE system will be implemented. However, before developing the plan, the change committee should first identify key messages of the communication and timing of the messages with respect to the implementation and change timelines.

The goals of developing the communication plan are to inform the users about the decision to implement the CPOE system and the motivations behind this decision, to create awareness about the coming change and how that will affect work processes, to explain the possible benefits and drawbacks of the system, and to explain the change plan and schedule.

The communication plan plays an essential role in informing users about what is coming in their ways and managing their expectations and concerns. For example, if from the pre-implementation survey, users express fear of compromising patient's privacy, then the communication plan should focus on addressing this fear. The effective communication plan should:

- Consider the users' requirements and needs.
- Use a variety of channels and mechanisms based on the situation and available recourses.
- Exploit leaders and champions actions to promote the change through their behaviour.
- Consider communicating achievements and short-term wins.
- Consider two-way communication either through champions and representatives in the change committee or through users' feedback and suggestions.
- Consider communicating how users' feedback and perspective have been incorporated.

S8.9 Support plan

After planning for when and how to implement the change, the committee must plan how to stabilize the change and support the users during the transition. The support plan should include:

- How to answer clinicians' questions about using the CPOE system.
- Where to report the system issues.
- Who will be available to provide support, especially during the first few weeks?
- What are users' preferences when it comes to asking for help?
- How to inform the users about the available support resources such as a hotline phone number, a helpdesk, or a website.
- What are the different support resources that the project can afford?
- Who will be available to conduct rounds on the units to observe how things will provide support as needed?

S9. Evaluating the change management plan

In the system development and design approach, the iterative process is used to present the design to users, gather feedback, learn from it, and go again. The UCCM process uses the same concept to evaluate the change management plan.

To identify issues as soon as possible before the actual implementation, the developed change management plan needs to be evaluated to spot potential issues and improve them. After the complete change management plan comes together, it can be presented to

the whole project team, including champions, superusers, project management team, and senior management, to obtain their perceptions and feedback on the plan.

Parts of the plan, such as the potential training and communication plans, can be shared with the users to get feedback. One possible way to do that is by interviewing a sample of the users or presenting the plan to a group of users and holding a Q&A session after the presentation and then updating the plan accordingly.

Presenting the change management plan to the users creates a shared understanding of what is happening and facilitates assessing and incorporating different perspectives to the plan.

S10. Monitoring and evaluation

All the previous UCCM steps are done before the actual implementation takes place. However, the remaining two steps will be executed after the implementation.

The monitoring and evaluation step includes two main tasks: evaluating the change management plan and evaluating the CPOE system.

Change management plan evaluation

For effective implementation of the CPOE system, decision-makers must choose the best change management plan that will prepare users efficiently for the change and increase their acceptance of the system. However, choosing the best plan is not enough. In addition, for planning, they need to monitor the progress of the change management plan and evaluate its effectiveness.

The change management plan's evaluation can be done using two concepts known as formative and summative evaluation. The two concepts are adopted from the education field. Robinson [159] explained them as follows: "there are two stages of evaluation – although each may be repeated – *formative evaluation*, which occurs during the running of the project, and *summative evaluation*, at the end."

The *formative evaluation* will be used to evaluate the effectiveness of the change management activities in preparing the users for the change. That includes evaluating whether the communication and training plans achieved their goals and satisfy users. One of the tools to be used in this evaluation is a short survey conducted at the end of each training session to examine the users' progress, as well as to measure users' awareness of

the project to evaluate the effectiveness of the used communication strategy. Regardless of the used tool, the evaluation should include the following questions [19]:

- Did the activity achieve its goals and objectives?
- Did the users benefit in the way that was intended?
- What were the obstacles and unintended consequences?

Performing the formative evaluation is necessary to monitor the progress in real-time, which helps identify risks and issues early to develop mitigation plans and/or update the original plans before it is too late.

Executing the plan is *not* an indication of its success. The post-implementation outcomes must be evaluated to find out if the intended goals have been reached or not. The second type of evaluation, *summative evaluation*, will be used to evaluate whether the change management plan has achieved its envisioned outcomes. The goal is to measure how well the users are satisfied with how the change was introduced to them. Did the used change management plan improve their experience with the CPOE system? Did it enhance their acceptance of the system or not? The answers to those questions will be used to indicate the effectiveness of the used change management plan.

While the results of this part will not lead to many changes to the plan because it is already done, the results are essential to:

1. Improve some aspects of the plan to be used later, such as the training material and communication channels. Those plans can be updated for future users to onboard.
2. Provide lessons for future projects. The CPOE system implementation is neither the last technology nor the last change the healthcare organization will go through.

To ascertain the effects of the change management plan, a summative evaluation in the form of a questionnaire, possibly with interviews, will be used [156]. The survey questions are inspired by the *Physician Order Entry User Satisfaction and Usage Survey* (POESUS) [17]. POESUS is a survey that was designed to measure users' satisfaction with CPOE implementation. POESUS was selected here because it was developed specifically

for CPOE systems and because of its strengths in comparing the results of CPOE implementations across hospitals [160].

This survey, presented in Appendix B, aims to answer the question "To what extent did the developed change management plan improve clinical users' acceptance of the CPOE system?". The survey contains 18 questions, whose response formats vary from five-point Likert scales (Excellent, Good, Average, Poor, Very Poor) to multi-option, fill-in-the-blank, and unstructured responses (for open-ended questions). The questions are distributed over three sections (See Appendix B for more details about the survey questions):

1. **Demographic information:** This section aims to collect demographic information that may affect clinician satisfaction with CPOE. In this section, demographic information and experience in healthcare will also be gathered.
2. **Self-reported computing and CPOE experience:** This section aims to gather information regarding clinicians' experience with the CPOE system and their level of comfort with computers in order to determine if their skills affect their satisfaction level.
3. **Users' level of satisfaction with CPOE implementation process**: The questions in this section aim to measure users' satisfaction level with the planning and implementation processes. The aim is also to measure how the used process affects users' feelings toward the implemented system.

The CPOE system evaluation

As mentioned earlier, the evaluation step has two parts: one part about the users' satisfaction with the change management plan that has been used during the implementation, and the second part about the users' acceptance and satisfaction with the CPOE system itself.

For the second part, the goal is to assess users' perceptions and satisfaction with the CPOE system following implementation. This assessment helps to understand the system's effectiveness in practice and improves the system's function. It also helps in improving the CPOE system usability issues. This evaluation has been discussed extensively in the CPOE implementation literature. Most of the presented work considers conducting a cross-sectional questionnaire after implementation to examine users' satisfaction with the CPOE system. Many of those questionnaires are also inspired by (POESUS), which was designed to measure user satisfaction with CPOE systems [17]. Other studies opt for

interviews to perform the same evaluation [145]. The satisfaction measurement can be done after the implementation or done at multiple points of time to examine changes in perceptions and satisfaction over time [145], [161].

Because the UCCM process focuses on the change resulting from the CPOE implementation process and not on the system design and functionality, the suggested evaluation tool will concentrate on measuring the clinicians' satisfaction with the change management plan and their perception about being involved in the plan's design process. However, the CPOE change committee should consider measures both the first and second parts.

S11. Providing ongoing support

One of the essential steps in any change is providing support after implementation to make changes stick. It is often too easy to go back to old ways of working; ongoing maintenance and support are essential to keep clinicians on track.

The CPOE implementation is a journey and not a final destination. After implementation, users gain first-hand experience with the system; they have time to discover its advantages and drawbacks. At this stage, users can express their concerns about the CPOE system issues that could affect their job. It is now the management's turn to listen to the users, as otherwise users may employ workarounds that can introduce risks and further issues. Those workarounds can be introduced to overcome the system design shortcomings or to overcome other non-design issues. As an example of non-design issue, a nurse interviewed by Cresswell et al. [23] highlighted that the computers that support the CPOE system are placed on heavy trollies to push around, which causes pain in the backside of the users. If the management does not solve the issues, the users could end up using paper during their rounds and then enter the information in the system later. This act could cause delays or serious problems if users entered the wrong information or lost their paper-based information.

In addition, the CPOE system is supposed to be regularly updated with new functions; therefore, users need to have continuous training to draw their attention to any new system functionalities and teach them how to take advantage of those new functions.

The ongoing support also includes continuous communication and continuous update to the communication mechanisms to accommodate new users and reassure experienced users if they have any concerns.

Table 13 UCCM process steps

Steps	Actor(s)	Goal(s)	Input	Output	Users involvement
S1. Building motivation to change	Leadership and Management	To create readiness for change by identifying why the change needs to occur and describing the future state.	• Current state and issues. • Organization vision. • Organization goals.	• An answer to why we need/have to change the current state, at this time. • Leadership engagement.	Indirect. By considering how to convince users about the change.
S2. Forming a Change Committee	Leadership and Management	• To attract key staff who will help lead the change. • To provide early and continual focus and support on users. • To actively involve users in the decision-making process.	A list of skilled and interested staff and members from senior management and other administrational departments who support the change.	An accountable, diverse committee that believes in and supports the change.	Indirect. In the form of representatives in the committee.
S3. Creating a vision	Change committee	• To clarify the direction where the change is heading. • To drive organization objectives.	• Organization vision. • Organization goals and objectives of implementing CPOE. • The desired future state.	A clear vision for what the future state should look like.	Indirect. • In the form of representatives in the committee. • Considering their goals and feelings. • Providing purpose and meaning to their effort.
S4. Analyzing context and workflow	Change committee	To acquire a comprehensive understanding of the tasks, work context, workflow, changes to users' work, and interaction with the CPOE system.	• Data collected using the available tools and methods. • The organization's goals. • Users' goals. • The created vision.	A holistic overview of the implementation context, tasks, workflow, and resources.	• Indirect. In the form of representatives in the change committee. • Direct. Through clinicians working groups
S5. Choosing champions and superusers	Change committee	To give users familiar faces to trust the change.	A list of interested and qualified staff who support the change.	Accountable champion(s) and superuser(s) who believe in and support the change.	Indirect. In the form of representatives in the change committee.

Steps	Actor(s)	Goal(s)	Input	Output	Users involvement
S6. Analyzing and identifying users and their requirements	Change committee	• To satisfy user's needs • To minimize user's resistance to change. • To gain users' trust, involvement, and commitment.	• The organization's goals. • The change vision.	• Users' characteristics and expectations and perspectives. • Users' requirements that meet the organization's goals and can be satisfied.	Direct. There is the core step involving users.
S7. Considering previous experiences	Change committee	To learn from the past.	The organization and peer organizations experience with similar projects.	• Lessons and best practices of CPOE implementation to be used in the change planning.	Indirect. In the form of representatives in the change committee.
S8. Developing the change management plan	Change committee	To break the coming change down into progressively more detail.	The outputs from all previous steps.	• Goals, approach, and timeline. • Workflow optimization plan. • Resistance plan. • Leadership engagement plan. • Measures plan. • Short-term wins, rewards, and recognition plan. • Training plan. • Communication plan. • Support plan.	Indirect. In the form of representatives in the change committee.
S9. Evaluating the change management plan	Change committee	To improve the change plan.	• Change plan. • User's feedback.	A revised/enhanced change plan based on received feedback.	• Indirect. In the form of representatives in the change committee. • Direct When some users are asked to evaluate the plan.
S10. Monitoring and evaluation	Change committee	To provide continued monitoring and intervention.	• User's feedback. • Evaluation reports from different departments.	• A revised/enhanced change plan. • Improved CPOE system.	Direct Through participating in evaluation surveys and interviews.

Steps	Actor(s)	Goal(s)	Input	Output	Users involvement
S11. Providing ongoing support	Change committee	To ensure that the change endures.	Continued reports and feedback from users and departments.	Changed individual behaviour to achieve organizational goals.	• Indirect. In the form of representatives in the change committee. • Direct Through their feedback.

4.7. Chapter Summary

This chapter proposed a User-Centered Change Management (UCCM) process for implementing CPOE systems in healthcare organizations, with a focus on improving clinicians' acceptance of these systems. This process considers clinicians as the center of the change and makes their requirements and needs a priority. The UCCM process combines the advantages of Kotter's change management model and the UCD approach. The anticipated primary benefit of the UCCM process, besides involving clinicians, is that it provides a guide usable by healthcare organizations on how to start planning for the change, who needs to be involved, and what kind of preparation is required to have an efficient implementation. The UCCM process provides a general change management plan that can be tailored to meet different requirements for different users and organizations.

The UCCM process has been developed to overcome some of the limitations observed in current case studies published in the literature. The UCCM process aims to mitigate most of the barriers and applies most of the recommendations that have been identified from the literature on the CPOE system implementation. However, the UCCM process is not considering usability issues, which are left to other existing approaches [7], [23], [114], [115], [118]. The UCCM process focuses mainly on the change management process of the implementation. For instance, to alleviate the resources and workflow issues, the UCCM process has suggested analyzing and understanding the CPOE system's context. Due to this analysis, the change committee should have enough knowledge about the organization's needs and limitations. To address issues related to clinicians' expectations, the UCCM process has steps to specify their requirements and include the suggested survey that will be used to collect user requirements for the change management plan.

The next chapter assesses the UCCM process coverage of the change management principles, UCD approach principles, and the clinicians' acceptance factors. It also validates the feasibility and usefulness of the proposed UCCM process and surveys against key healthcare informants and other healthcare guidelines.

Chapter 5. UCCM Process Assessment and Validation

This chapter first assesses how well the UCCM process covers the change management and UCD approach principles. Additionally, it considers the UCCM process coverage of the clinicians' acceptance factors that have been identified in Section 3.2.

The second part of this chapter validates the feasibility and usefulness of the proposed UCCM process with key healthcare informants and against other healthcare change management guidelines.

The chapter concludes with an introduction to the process that will be followed to evaluate the UCCM process.

5.1. UCCM Process Steps

To make reading this chapter easier, the UCCM process steps are listed again here for reference.

S1. Building motivation to change

S2. Forming a change committee

S3. Creating a vision

S4. Analyzing context and workflow

S5. Choosing champions and superusers

S6. Analyzing and identifying users and their requirements

S7. Considering previous experiences

S8. Developing the change management plan

- **S8.1.** Goals, approaches, and timeline
- **S8.2.** Workflow optimization plan
- **S8.3.** Resistance plan
- **S8.4.** Leadership engagement plan
- **S8.5.** Measures plan
- **S8.6.** Short-term wins, rewards, and recognition plan

S8.7. Training plan

S8.8. Communication plan

S8.9. Support plan

S9. Evaluating the change plan

S10. Monitoring and evaluation

S11. Providing ongoing support

5.2. Coverage Assessment

The UCCM process was developed based on change management and UCD approaches. Additionally, because it is user-centered, it was established with a goal to incorporate clinicians' acceptance factors. Hence, this section reviews the change management and UCD principles and then assesses whether the UCCM process covers those principles. It also examines how well the UCCM process considers the factors that could affect clinicians' acceptance of the CPOE system.

The goals of this section are to:

- Confirm whether the UCCM process has missed any principle or factor during the mapping between the two approaches.
- Provide a qualitative explanation of the UCCM process coverage of the principles and factors using the values *explicit*, *implicit* and *no coverage*.

5.2.1 Coverage Assessment of Change Management Principles

Satisfying the change management principles increases the chances of success of the UCCM process in managing the change associated with the CPOE system implementation. It is also an indication of the UCCM process's ability to increase clinicians' acceptance of the CPOE system.

Building on what has been discussed in Section 3.3.2, specifically, Table 8 and accumulated knowledge from other sources regarding change management [162]–[165], eleven principles have been identified as crucial for the success of change initiatives. In order to assess the coverage by the proposed UCCM process, I compare the process steps to these eleven change management principles.

In the following paragraphs, I will introduce each principle and discuss whether the UCCM process covers it. If yes, I will also explain which of the UCCM process steps cover that principle. Table 14 shows each principle and its corresponding step(s) in the UCCM process.

P1. Convincing need for change

Change can be a result of external or internal pressure. Having a strong case about the need for change and the force behind it is essential in achieving people's acceptance of the change. It is hard for people to support change if they do not fully understand its importance and benefits to them and their organization.

In the UCCM process, the first step, *building motivation to change*, is about answering the question, "why do we need/have to change the current status at this time?". In this step, decision-makers should create motivation to change and convince users about the necessity of the proposed change. Developing motivation also includes explaining the different benefits that will result from the change as well as the possible trade-offs.

P2. Leadership engagement

In large projects such as change initiatives, leadership engagement at various levels of the organization, including executive sponsorship, supervisors, and managers, is necessary. Their support is essential to advocate and maintain support for the change. Leaders must be active, visible, and engaged in achieving the desired goals.

In the UCCM process, leadership engagement has been considered in two steps (*building motivation to change* and *developing the change management plan: leadership engagement plan*). Because of its importance in supporting the CPOE implementation, the UCCM process includes a separate plan for preparing how leadership engagement should look.

P3. Clear vision and strategy

A clear vision of how the future will look like should be created and made accessible to the whole organization before starting to implement the change. Creating such a vision is necessary to show people why change is needed and what are the

expected results of that change. Having a clear vision and strategy to achieve that vision will ensure that the whole organization is working in the same direction and towards the same desired goals.

In the UCCM process, the third step *creating a vision*, explains the importance of the vision and what to consider when making that vision. Additionally, the UCCM process includes another step, *developing the change management plan: goals, approach, and timeline*, in which the strategy of how to achieve the vision is created.

P4. Constant communication and dialogue

Introducing change is not an easy process. Change brings fear and resistance. This is why creating a robust communication plan is essential not only to achieve stakeholders' buy-in by letting them know what is going on and how it will affect them but also to get their input on how things need to be changed.

In the UCCM process, the communication principle is considered in phases starting by collecting information from *analyzing context and workflow, analyzing and identifying users and their requirements* and *considering previous experiences.* This is further continued by creating a communication plan that considers the different needs and requirements of the targeted audience (*developing the change management plan: communication plan*).

P5. Change champions

To fuel the enthusiasm of employees towards the change and achieve their buy-in, employees need to see their peers proactively supporting change. The responsibilities of change champions include promoting the change process, communicating with employees, training, and monitoring progress.

In the UCCM process, the importance of champions and superusers' roles are reflected by including a separate step called *choosing champions and superusers*. The selection of champions and superusers needs careful planning to select the right people.

P6. Strong and multidisciplinary change team

Building a change team is essential to manage change direction and responsibilities. However, because change is multidisciplinary in nature, change teams must also be multidisciplinary to ensure a collaborative approach from various stakeholders. In addition, the change team should have a strong relationship with other stakeholders to be able to communicate well, and have a passion for the change.

In the UCCM process, most decisions are planned and executed by the "change committee", whose members and responsibilities are considered in the second step called *forming a change committee*.

P7. Remove barriers to change

Another important principle in change management is planning to remove barriers that may impede stakeholders from adopting change. In every change initiative, there are barriers that could hinder the change implementation. Those barriers include stakeholder's resistance to the change and other organizational barriers that must be identified and addressed as early as possible.

In the UCCM process, removing possible barriers that could affect users' acceptance of the change has been considered in many forms. The process starts by *analyzing the context and workflow* step in which the change will take place in order to remove any barriers caused by internal or external environments. It is also done in *analyzing and identifying users and their requirements* step by analyzing the users who will be affected by the change to create a particular plan that considers resistance reasons and ways to mitigate the effect of those reasons. In addition, removing barriers can be done by training stakeholders properly for the change and providing continuous support to monitor new obstacles (*developing the change management plan: training plan and support plan*).

P8. Stakeholders engagement and participation

Stakeholders who are affected by the change need to become part of the process. Their participation is an essential factor in the success of the change because it gives them a sense of ownership beyond buy-in. One way of engaging stakeholders is by

asking and acting on their input whenever possible. That includes explaining why some of their input cannot be acted upon.

In the UCCM process, stakeholders' engagement and participation is the primary goal of the process. During each step of the process, users' engagement is considered and discussed. However, three steps consider this engagement explicitly (*analyzing and identifying users and their requirements, evaluating the change plan*, and *monitoring and evaluation*).

P9. Comprehensive training

To ensure stakeholders effectively adopt the change, they must be equipped with the necessary skills and knowledge. Creating a comprehensive training plan impacts stakeholders' productivity positively and satisfaction and vice versa.

In the UCCM process, there is a particular plan called *developing the change management plan: training plan* that discusses planning how to train users on the new CPOE system. The plan considers the different users' needs and requirements. It also considers the availability of resources and how to employ them.

P10. Goals and measurements

Goals are essential to help people understand why the change is needed. On the other hand, measurements are necessary to ensure that the goals of the change are being met. Having measures in place gives accountability to the change process.

In the UCCM process, setting goals and measuring whether they have been achieved or not is considered when *developing the change management plan*. First, *goals, approach, and timeline* is the step where the goals are set and agreed on. Then, in the *measures plan* step, metrics and measures are identified to evaluate the progress towards achieving the goals. Additionally, a *short-term wins, rewards, and recognition plan* is another way of measuring progress. Finally, the *monitoring and evaluation* step measures the overall progress after the actual implementation of the change.

P11. Reinforce change

Implementing the change is not the end. There is a need to reinforce change; otherwise, it will not stick. It is essential to plan ahead how to strengthen the change. That includes creating and rewarding meaningful short-term wins, conducting post-implementation evaluations, and responding to any spotted weaknesses or barriers.

In the UCCM process, different measures are taken to ensure change is sustained after the implementation is done. Those measures are discussed in *developing the change management plan: short-term win*s, *rewards, and recognition plan* where the mechanism of rewarding and recognizing achievements is defined. Furthermore, the *monitoring and evaluation* step reinforces change by considering users' feedback and perspective after the implementation. *Providing ongoing support* is another way to sustain the implemented change where difficulties with the CPOE system are dealt with to remove any obstacle that may affect user experience.

In conclusion, the UCCM process does cover all eleven change management principles. In fact, the UCCM process goes beyond these principles. For example, change management principles do not consider learning from previous experiences in dealing with change. Moreover, the UCCM process realizes the importance of understanding the context where the change is happening while the principles do not realize that. Also, the change management principles focus on implementing the change with no attention to stakeholders' requirements. Table 14 is a brief representation of which steps cover which principles. There is an overlap between steps and principles. Many principles are considered within multiple steps, either explicitly or implicitly.

In the discussion above, I did not include the details of how the UCCM process steps satisfy the principles because: first, the goal of this section is to assess the UCCM process coverage of the change management principles to verify if the process did miss any principle, and second, to avoid repetition. The steps are presented in detail in Chapter 4.

Table 14 Coverage of the change management principles by the UCCM process steps

UCCM process steps		Change management principles										
		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11
S1		■	■									
S2							■		■			
S3				■								
S4					■	■		■		■		
S5						■						
S6					■			■	■	■		
S7					■					■		
S8	S8.1			■							■	
	S8.2											
	S8.3							■				
	S8.4		■									
	S8.5										■	
	S8.6										■	■
	S8.7							■		■		
	S8.8				■							
	S8.9							■				■
S9									■			
S10								■	■		■	■
S11								■				■

■ Explicit coverage ■ Implicit coverage

5.2.2 Coverage Assessment of UCD Principles

The UCD approach is based on seven fundamental principles that are essential to ensure the success of the application of the UCD during the systems design process [89], [166]–[170]. In the following section, I will present each principle along with an explanation of how the UCCM process adopts/covers that principle.

D1. Early and continual focus on users and their tasks

When designing a system, the designer must focus on users' characteristics, cognitive behaviour, and attitudes to ensure full support for users who will use it to perform their required tasks. That also includes focusing on the real world's tasks and the specified environment to appropriately allocate functions between the user and the system.

One of the main goals for developing the UCCM process is to focus on users when planning for the change associated with the CPOE implementation. So, the idea of making users (instead of the CPOE system) the center of the change is what makes the UCCM process unique. All of the UCCM process steps focus on users and how to satisfy them either directly or indirectly.

D2. Multidisciplinary design teams

The system development lifecycle includes different phases and aspects. Each of those phases and aspects requires different sets of skills and expertise to be achieved. Accordingly, the system design and development should be performed by multidisciplinary teams that include system architects, programmers, usability designers, interaction designers, and users.

One of the UCCM process steps is *forming a change committee*, in which a committee that involves multidisciplinary members with different skills and expertise is developed to manage the change. Due to the variety in the membership, the committee facilitates the management and consideration of various aspects.

D3. Active user participation

Focusing on the users and their requirements is not enough. Their active participation early and continuously throughout the entire system lifecycle is essential. In case the intended users groups of the system are too large, representatives of users should be selected. Planning for selecting users and how to involve them should be done from the beginning of the project.

Users' engagement and participation are an essential factor in the UCCM process. That includes the participation of users in the change committee. Users' participation is also achieved by incorporating users' requirements and feedback during the change plan development.

D4. Clear understanding of users' requirements

Developing a "perfect" system with advanced functions that are not aligned with users' needs and requirements is a recipe for failure. The system design shall be

based on the actual needs of the users who will use it. Understanding user requirements is a science by itself that includes different techniques and tools.

In the UCCM process, the change plan is developed based on the identified user requirements. Those requirements are collected either directly by asking the users or indirectly by analyzing the users and context. In addition, the involvement of the users in the change committee is another way to preserve a continuous understanding of the users' requirements.

D5. Early prototyping to evaluate and develop design solutions

Using prototypes in the UCD is a way to evaluate ideas, elicit requirements and visualize ideas and solutions. Prototypes' goal is to create a shared understanding of the user's needs and how the system is designed to meet those needs. It also helps design teams in making more user-focused decisions by collecting and analyzing feedback from users regularly. Real end-users should evaluate prototypes in context.

In the UCCM process, after developing the change management plan and before implementing it, the plan is evaluated by users and updated accordingly in the step *evaluating the change plan*. In this step, the developed plan is presented to the whole project team, including the change committee, champions, and superusers, to obtain their perceptions and feedback on the plan. In addition, other users are also included in the evaluation process.

The difference between the UCCM process and the UCD approach is that the presented change management is not a prototype but a draft of the plan. However, decision-makers can develop a prototype of any of the sub-change plans and evaluate it.

D6. Iterative design process and evaluation

The system design process is a cycle of design, evaluation, and redesign. It starts by designing the initial system, evaluating the design with real users using prototypes, and then analyzing users' feedback and redesigning the system. This approach allows incremental deliveries as the design teams gain more understanding

of the users. Therefore, the design can be evaluated by the real users before it is made permanent.

The last three steps of the UCCM process, *evaluating the change plan*, *monitoring and evaluation*, and *providing ongoing support*, represent the iterative design in the UCCM process. That is because the change management plan is improved incrementally based on users' feedback before, during, and after implementing the change.

D7. Integrated/ holistic design

All aspects that will be affected by the introduction of the new system should be developed and/or modified in parallel with the system design. The aspects could include work organization, work practices, user training, etc. Other elements of the context, such as hardware and social and physical environments, must also be considered.

The eighth step in the UCCM process, *developing the change management plan*, involves nine sub-plans that consider various aspects of the change management plan's goals, approach, measures, training, etc. Dividing the plan into sub-plans helps decision-makers to plan for the change in a holistic way.

Additionally, the context and workflow analysis helps the decision-makers see the whole system and consider how to change its different aspects in parallel.

In summary, the UCCM process succeeds in covering most of the UCD principles. However, because the UCCM process focuses on the organizational change and not on the CPOE system itself, the UCCM process falls short in considering the usability of the CPOE system. At the same time, the UCCM process considers aspects beyond the UCD principles, such as learning from previous experiences and creating a vision. Table 15 shows each principle and how it was covered by the UCCM process steps.

Once again, to avoid redundancy, the above explanation gives an overview of how the UCCM process steps cover the UCD principles. Chapter 4 explains each step in detail.

It is worth mentioning that some common principles exist in change management and UCD, such as multidisciplinary teams and stakeholders' engagement and participation.

Table 15 Coverage of the UCD principles by the UCCM process steps

			UCD principles						
			D1	D2	D3	D4	D5	D6	D7
UCCM process steps	S1								
	S2								
	S3								
	S4								
	S5								
	S6								
	S7								
	S8	S8.1							
		S8.2							
		S8.3							
		S8.4							
		S8.5							
		S8.6							
		S8.7							
		S8.8							
		S8.9							
	S9								
	S10								
	S11								

Explicit coverage Implicit coverage

5.2.3 Coverage Assessment of the Clinicians' Acceptance Factors

In section 3.2, I did a thorough literature review to identify the factors that influence clinician's acceptance of a CPOE system. The result of the review is presented in Table 7 (in Chapter 3). In this section, I will explain how the UCCM process considers those factors.

Implementation strategy factors

I1. Resources

The main issue with resources when implementing the CPOE system is scarcity, either in personnel or material resources. It is recommended to proactively plan ahead and be well prepared to procure essential resources.

To manage resources effectively and take full advantage of them, the UCCM process includes two steps that require a complete analysis of the settings

where the CPOE will be implemented and the users who will be affected by the implementation. The steps are *analyzing context and workflow* and *analyzing and identifying users and their requirements.*

The UCCM process approach starts by identifying the available resources and the possibility of providing additional resources if needed. This helps planning for the change according to what is available. The full inventory of resources, including personnel, gives decision-makers the ability to make informed decisions.

I2. Workflow

Workflow disruption due to the introduction of the new CPOE system is a challenge to users. Such disruption affects users' ability to adapt to the new routine and, as a result, affects their willingness to use and accept the system.

To ensure a better solution to the workflow issues, the UCCM process requires a full analysis of the context and workflow that exist before the CPOE implementation. The UCCM process also involves planning on optimizing the workflow before the actual implementation of the CPOE system.

I3. Users' perceptions

Users' perceptions of the CPOE system are a significant factor affecting their acceptance of the system either positively or negatively. If users have a positive perception of the CPOE system's usefulness, they will most likely accept and use the system and vice versa.

To improve users' perceptions of the CPOE system, a collection of measures can be taken, such as creating a strong case that helps users understand the need for the change and the direction in which the project is going. Addressing users' fears and questions through planning for effective communication is another measure. Additionally, leadership engagement and the provision of incentives play roles in improving perceptions.

The UCCM process took users' perceptions into consideration. That can be noticed clearly in the following steps: *building motivation to change, creating a vision, analyzing and identifying users and their requirements,* and *developing the*

change management plan including Resistance plan, Leadership engagement plan, training plan, communication plan and support plan.

Other steps of the process also consider users' perceptions indirectly by removing possible barriers, such as *providing ongoing support.* Users' perceptions of the change itself are also considered in the UCCM process through the users' active participation in the planning process and through their evaluation of the developed change plan before implementing it.

I4. User's engagement/involvement factors

Users' engagement is a critical factor in designing or implementing any plan or system. The success of the CPOE implementation requires users' engagement in every step. This is why the UCCM process was developed. However, users' engagement during the design and development of the CPOE system is out of the thesis scope. The UCCM process focuses on engaging the users in planning and preparing for the change that will be introduced because of the CPOE system.

Users' engagement in developing the change plan for implementing the CPOE is one of the UCCM process goals. The question of *how users are involved?* is considered when developing each step of the process. However, users' engagement is not always direct. In some cases, their engagement can be in the form of representatives, for instance, in the change committee.

I5. Special people factors

Using special people to plan and promote the change is another factor in users' acceptance of the CPOE system. In the UCCM process, special people are employed to be part of the change management team. Their participation starts from the beginning when a change committee is formed. It continues by choosing champions who work as ambassadors of the change and training superusers to provide the necessary support during and after the implementation.

I6. Training and support factors

Users need to gain confidence in their abilities to use the CPOE system efficiently. Getting the right amount of training at the right time using the right tools is a must

to increase users' acceptance of the CPOE system. Sometimes, training could go beyond the CPOE system to cover even computer basics.

Another way to improve users' confidence in the system is to provide adequate support to the system and the users. That includes responding to users' feedback, maintaining the system, and updating it.

The UCCM process recognizes the importance of training and support for the CPOE implementation. The training and support plans in the UCCM process are developed after a comprehensive analysis of the environment, users, and their requirements. The goal is to have plans that meet the users' needs and requirements to satisfy them as much as possible.

Usability issues factors

The last group of users' acceptance factors of the CPOE system is concerned with the design and usability of the CPOE system. The UCCM process is developed as a change management plan that assists the decision-makers while implementing the CPOE system. Therefore, the usability issues factors are out of the UCCM process scope and have not been addressed by the process. However, based on the literature review on the factors that affect users' acceptance of the CPOE system, five recommendation were identified to improve the CPOE usability:

1. Perform a pre-implementation usability test with users and learn from their feedback [7], [23], [118];
2. Ensure system usefulness and ease of use, and that includes a consistent and user-friendly interface [105], [114], [118], [121];
3. Consolidation of similar order sets that are tailored to the hospital's clinical workflows [114], [115], [118];
4. Integrate the CPOE system to the local context in order to eliminate inefficient and poorly fitting functions [13], [23], [105]; and
5. Select a CPOE system that provides interoperability with existing information systems [118].

Combining those recommendations with the UCCM process would address the usability issues and improve the users' overall experience with the CPOE system. For instance, the

steps *analyzing context and workflow* and *analyzing and identifying users and their requirements* can be done early on the project to use the results when designing/customizing the CPOE system. Additionally, the *User Requirements Survey* can be updated to include questions regarding the design requirements and then be distributed before designing the system.

Table 16 shows how the UCCM process considered the clinicians' acceptance factors for the CPOE systems. Although, the sub-steps S8.1 *goals, approach and timeline* and S8.5 *measures plan* do not cover any of the acceptance factors, they play an important role in enhancing users' acceptance of the system. The ultimate goal is to determine how best to prepare users for the change with minimum disruption.

Table 16 Coverage of the clinicians' acceptance factors by the UCCM process steps

			Clinicians' acceptance factors						
			Implementation strategy						*CPOE*
			I1	I2	I3	I4	I5	I6	U
The UCCM process steps	S1				Explicit				No
	S2					Implicit	Implicit		No
	S3				Explicit				No
	S4		Explicit	Explicit				Implicit	No
	S5						Explicit		No
	S6		Explicit		Implicit	Explicit		Implicit	No
	S7				Implicit				No
	S8	S8.1							No
		S8.2		Explicit					No
		S8.3			Implicit				No
		S8.4			Implicit				No
		S8.5							No
		S8.6			Explicit				No
		S8.7			Explicit			Explicit	No
		S8.8			Explicit				No
		S8.9						Explicit	No
	S9				Implicit	Explicit			No
	S10					Explicit		Implicit	No
	S11				Implicit			Explicit	No

Explicit coverage Implicit coverage No coverage

5.3. Validation Process

In general, the term validation means to check or to demonstrate that something is true and acceptable. In this chapter, validation is the process of confirming that the proposed UCCM process is acceptable and leading to the intended results by objective evidence. The UCCM validation process involves the following two iterations:

1. **Validation with key healthcare informants:** To validate the need and feasibility of the UCCM process and its two surveys.
2. **Validation against other healthcare change management guidelines:** To examine the UCCM process against other known guidelines to ensure its usability.

5.3.1 Validation with Key Healthcare Informants

The first step of validating the UCCM process starts even before the actual creation of the process. The need for a change management process that focuses more on clinicians began after a discussion with a healthcare informant in a Canadian hospital. The informant stated that many of the hospital's technology-related projects have failed because of clinicians' resistance and refusal of using the implemented systems. At the time of the meeting, the hospital management was planning to implement a CPOE system. Their main concern was how to convince clinicians to accept and use the CPOE system in order to avoid project failure. Hence, the idea of developing a new change management process that focuses on clinicians started to address that issue.

After rounds of literature reviews and discussions, the idea of developing a change management plan that is inspired by UCD principles was born. A first draft of the new change management plan was generated. Then, I introduced the new plan to healthcare informants and the CPOE project manager at that time to validate its feasibility, i.e., its ability to increase clinicians' acceptance of the CPOE system. I started by introducing the issue and my proposed approach to address that issue. After they agreed on the need for such a solution, I presented the plan steps in detail to get their insight into the feasibility and usefulness of each step. If the informants disagreed that a step is feasible, I corrected the issues or concerns raised and updated the steps accordingly. After the first meeting, I named the plan *user-centered change management process* to reflect the fact that it combines change management and UCD.

I presented the steps four times to different informants with different backgrounds and roles (clinicians, managers, Chief medical informatics officer) in the CPOE implementation project. Some of them are members of the CPOE project management in the hospital, and others are members of the CPOE implementation committee of Ontario's CHAMPS[2]. After each meeting, the UCCM process was improved. During some sessions, I brought issues mentioned by some informants in previous meetings to examine if other informants agreed on those issues. The result was always yes; they agreed.

Holding those meetings helped me validating the need for and feasibility of the UCCM process. It also helped me update the steps by benefiting from healthcare informants' experience in healthcare in general and their previous experience with smiler projects. I also used the meetings to confirm the results of the literature review that I have done. Appendix F presents a summary of those validating meetings.

In addition to the UCCM process steps, the two surveys "User Requirement Survey" and "User Satisfaction Survey" were developed and presented in some of the meetings. No concerns were raised regarding the style, content, and usefulness of these surveys. The only major issue was that users may expect that all their requirements will be addressed. To manage users' expectations, a note was added at the beginning of the User Requirement Survey as the following:

NOTE: *Please be advised that not all requests can be accommodated. The result of the survey will be used as a reference to improve the CPOE implementation process. No changes will be made to the CPOE system itself.*

Both of the surveys were approved by the hospital and university research ethics boards. The User Requirements Survey was actually deployed in Hospital A as a pilot, with 14 practitioners, with 11 full responses (7 physicians and 4 nurses). See Appendix D for the results. Although there are too few answers for an extensive analysis, the results already suggest differences between nurses and physicians with respect to fears and attitudes related to CPOE in that hospital. The top fear of physicians relates to increased workload and time (as reported in the literature), which means better communication is needed here to

[2] https://www.champlainhealthline.ca/

manage expectations. The two types of practitioners are however both concerned about insufficient training and communication, but with training needs and desired formats that vary considerably. In addition, the types of anticipated support also differ, with physicians expecting to rely considerably on IT support while nurses plan to rely more on colleagues. This is the kind of user-centered data that will indeed help shape and tailor the training and communication plans to different groups and individuals.

5.3.2 Validation Against other Change Management Guidelines in Healthcare

In this section, I reviewed some of the change management frameworks/guidelines in healthcare. I have considered this topic before in Section 2.3.3; however, here I am expanding the topic by adding more explanation and comparing them with the UCCM process. My focus is on change management frameworks that emanate from lessons learned and change management key elements.

The national change management framework by Canada Health Infoway

The framework was developed by the Pan-Canadian Change Management Network to guide the change management associated with information and communications technologies (ICT) health projects [19]. The framework was based on the experience from leading practices and lessons learned for managing change in eHealth projects from across Canada. Its goal is to provide a guide and toolkit that can:

- Manage people and processes;
- Support change management leaders and practitioners working within ICT projects in healthcare; and
- Provide a useful resource for front-line clinicians, managers, and senior leaders when implementing ICT projects in healthcare.

The framework focuses on change management practices related to people and organizations that are going through changes within the context of ICT projects in healthcare. It incorporates six core change management elements:

- **Governance and leadership**

Governance explains the mechanisms that guide and regulate the course of an organization or system. It sets a project's direction and aims by answering two main questions: *what are we doing?* and *why are we doing it?* Having strong governance improves the project's decisions and buy-in from stakeholders. It also establishes clear roles and responsibilities throughout the project.

In addition to governance, leadership and accountability must be defined to motivate others to adopt the proposed change. Healthcare change projects' success requires complete support from the senior executive team, including its CEO.

In conclusion, identifying an effective governance structure and leadership is essential to ensure that change progresses as expected.

- **Stakeholder engagement**

Stakeholders here are the actual people who can affect or who are affected by the change. Because of their important role in the project's success, stakeholders' behaviours and needs must be understood and considered when planning for the change. The goal of their engagement is to gain their trust and commitment towards the project.

- **Communications**

Without full awareness of the project strategy and the desired goals and objectives, it will be hard for the stakeholders to recognize the value of the change and engage in it. Consistent and repeated communication is essential to solicit feedback from stakeholders, provide stakeholders with the necessary information to make informed choices regarding the project, build trust towards the change, and report progress to be responsible contributors to success.

- **Workflow analysis and integration**

The first step to incorporate a new tool or practice is to analyze and understand how people work and conduct their business. Failing in doing so can cause annoying disruption to work routine and potentially people resistance to the proposed change. Additionally, workflow analysis and assessment allow decision-makers to early identify potential roadblocks, additional opportunities for change, opportunities to communicate the potential benefits of change, and stakeholders who may become champions or who may create resistance to the change process. That early discovery helps integrating

workflow improvements and technology effectively into operations leading to better adoption by users. The ultimate goal of workflow analysis and integration is to integrate people, processes, and technology effectively.

- **Training and education**

In order to prepare users for the coming change, they need to be educated and trained on how to use the newly implemented system. Education refers to a program of instruction that aims to develop knowledge or skill. Education should start in the early stages of the change process to achieve understanding and buy-in as early as possible.

On the other hand, training refers to activities that improve a recipient's performance or help the recipient attain a required level of knowledge or skill. Training should be delivered closer to when the user will need to use the system.

- **Monitoring and evaluation**

Starting from the planning phase, the benefits that are anticipated from implementing ICT in healthcare are identified, so later on, decision-makers can evaluate whether these benefits are realized over the longer-term or not. Those benefits can be used as an indicator of project success.

However, waiting until the end of the project is not ideal. Ongoing monitoring and evaluation of the process are necessary to identify risks early on. That will help to improve the process and recognizing success opportunities. In order to take full advantage of ongoing monitoring and evaluation and avoid repeating mistakes, the recognized opportunities and the learned lessons should be integrated in real-time.

Each of the elements mentioned above is explained in more detail in the original document. Additionally, a list of tools and resources that can be used is provided at the end of each element as a reference.

The national framework does not provide a systematic approach to managing change. Instead, it provides a practical resource to highlight key elements of an effective change management plan without a particular sequence. The intention is to assist those who are new to change management and to provide sample tools and templates they can use.

In comparison to the UCCM process, the UCCM process is more systematic. It provides clear steps and instructions from the beginning of the change. The steps are presented in a sequential form to guide decision-makers from the start to the end of the change planning and implementation. The UCCM process covers all the elements that have been mentioned in the framework, and more. For instance, the UCCM process takes previous experiences with the system implementation in consideration when planning for the change. It also considers the context where the system will be implemented specially when planning for training, communication, and support aspects of the change management plan. Additionally, the UCCM process provides two surveys that were created and validated specifically for the CPOE implementation to collect users' requirements pre change and to measure their satisfaction with the change after implementation.

Both the national framework and the UCCM process focus on people; however, the UCCM process is explicitly developed to make the people/users the center of the change. In the UCCM process, users' involvement is considered in every step either directly or indirectly. One important form of this involvement is evaluating the created change management plan with the users before the actual implementation of it. Moreover, unlike the national framework, the UCCM process focus is on one type of stakeholders, the clinicians who will be the end users of the system and the most affected stakeholders by the CPOE implementation.

Additionally, the national framework was developed specifically for the Canadian healthcare system. However, the UCCM process is not limited to a specific healthcare system.

Although the UCCM process suggests a collection of tools to be used during each step. The national framework list of tools and templates is excellent. The UCCM process can further benefit from the resources provided in the framework.

The UK's National Health Service (NHS) change management guidelines

In 2010, The NHS published a document that provides best practice guidance on change management within a program or project to implement Electronic Rostering or Staff Bank software or solutions. The goal is to support acute care, primary care, and mental health trusts implementing large-scale change through e-rostering or staff bank solutions [84]. The Guidelines include six steps:

1. **Know where you're going and why**

   In this step, the project team uses a project management approach to establish the project business case, milestones, and leadership team. That includes identifying sources of the required information, engaging key stakeholders, and considering feedback from previous implementations in the area in order to develop the business case. This step includes two key activities: selecting the project team and mobilizing the leadership team.

2. **Analyze and design**

   The second step is considering design options, developing a delivery strategy to deliver the change, and understanding its impact on stakeholders. In order to achieve a full understanding of the solution design and minimize resistance, considering stakeholders' requirements is the key.

3. **Gain commitment**

   Gaining stakeholders' commitment to the project required preparing them for the implementation and getting them ready for change. That includes conducting pilot testing and assessing readiness for change**.**

4. **Deliver it**

   At this stage of the project, it is time to execute the planned change. Delivering the change starts by training staff on the new system and how to implement the changes. Additionally, staff must be informed of change progress and short-term successes to maintain their commitment and ease resistance.

5. **Reinforce it**

   Reinforcing the change requires reviewing and embedding the new workflows. It also requires learning from captured lessons and feedback to overcome weaknesses.

6. **Sustain it**

   The last step is about sustaining the achieved change by measuring change outcomes against the predefined goals and planning for continuous improvement and sharing success stories.

Unlike the national change management framework, the NHS change management guideline is more systematic. The guidelines provide sequential steps that must be done in a specific order. However, in comparison to the UCCM process, the steps only highlight

what should be done in each step. It is not clear how to execute each step or what kind of tools should be used. For example, in the fourth step "deliver it" training staff on new systems was mentioned as a task that should be accomplished without any further details on either how or when. In contrast, the UCCM process involves several steps to plan for the training. It starts by analyzing the context and workflow to identify the environment where the system will be implemented and to identify the available resources. Then, analyzing the users and collect their requirements using a survey. Finally, the training plan is created based on the information collected for the previous steps. Besides, the training plan is evaluated by change committee and users before execution. The same steps are applied when creating the communication plan as well. The UCCM process also provides a list of suggested tools and methods that can be used to execute steps releasing the decision-makers from the burden of searching for tools.

Additionally, the NHS change management guideline is not about the change associated with implementing a HIT system; it is about implementing a new system in healthcare organizations, and the users are healthcare personal. So, this guide can be applied to all change efforts within healthcare.

5.4. UCCM Process Evaluation

This research has started as a collaboration with a Canadian hospital that was planning to implement a CPOE system. The goal was to evaluate the proposed UCCM process in that hospital using a real-time case. I obtained the ethics approval from both the hospital and the University of Ottawa. I developed questionnaires in English and French to be distributed to clinicians at the hospital. However, many challenges prevented that evaluation starting by the CPOE project been postponed several times and ending with a global pandemic. During the current health crisis, it is impossible to evaluate my approach using a real-time case study, as hospitals (including the one I collaborate with) are still in crisis management.

Because of the current situation, a retrospective case study [171] is introduced to evaluate the UCCM process. The case study is presented in the next chapter.

5.5. Chapter Summary

This chapter's goal was to examine the UCCM process usefulness by 1) assessing its coverage of the change management principles, UCD principles, and clinicians' acceptance factors; 2) validating the UCCM process with healthcare informants and against other change management guidelines in healthcare.

The first part of the chapter has shown that the UCCM process covered all the main change management principles and UCD. This result was expected because the UCCM process was developed based on Kotter's model and the UCD approach. However, the goal was to confirm if the UCCM process had missed any principle during the mapping between the two approaches.

Moreover, examining how the UCCM process considered the clinicians' acceptance factors has shown that the UCCM process properly considered the first group of factors related to the implementation strategy. However, UCCM does not consider the second group that is related to the CPOE system and its usability. That is because the UCCM process is considering the change accompanying the implementation of the system and not the system design itself. Nevertheless, combining existed solution such as a pre-implementation usability test to the UCCM process could be beneficial to address usability issues in addition to the implementation strategy issues.

The second part of the chapter exhibited that the UCCM process provides a valuable approach to help decision-makers plan change implementation. While there are change management guidelines that consider change in healthcare, the UCCM process offers more advantages over those guidelines, including a systematic process with clear sequential steps. Each step is explained in detail, including the goal of the step, who is responsible for it, how to execute it, and what tools to use. Additionally, the UCCM process is developed for healthcare information technology (CPOE systems). The comparison between the UCCM process and those other guidelines show that the UCCM process has not only considered the same main elements but has added other elements, especially those that consider the satisfaction of the end-users who are the main target of the change.

The next chapter presents a retrospective case study on a report on the review of Island Health's IHealth system.

Chapter 6. Case Study: Island Health's *IHealth* EHR System

This chapter presents a case study that considers concerns about the use and adoption of the *IHealth* system, an advanced EHR system introduced by Island Health[3] in British Columbia, Canada. The chapter starts with an overview of the case study and the system under investigation. Then, it discusses the system issues that are related to change management. The chapter illustrates how the use of the UCCM process could assist in avoiding those issues. Finally, the benefits of the UCCM process, including those related to the project budget, are discussed.

It is worth mentioning that this case study is considering the project at the time of the report and does not provide a follow-up with updates.

6.1. Case Study Overview

This case study is based on a report on the review of Island Health's IHealth system by Ernst & Young (EY) [171]. In September 2017, the ministry of health engaged with EY to conduct an independent review of the IHealth system to establish the project's status and issues.

This case study was chosen because it provides a thorough review of the challenges that result from implementing an EHR system that includes CPOE. It enables evaluating how the UCCM process would help Island Health avoid many of the challenges of implementing the IHealth system and save some costs and efforts.

6.1.1 The IHealth System

In 2011, the Island Health implemented an Island-wide EHR system in all of its acute-care facilities using a single instance of Millennium, an EHR system developed by the vendor

[3] https://www.islandhealth.ca/

Cerner[4]. To bring the EHR system to HIMSS stage 6 functionality (technology-enabled medication), the Island Health Board of Directors approved a plan to implement additional functionality to the EHR to replace paper-based processes with advanced electronic functionality called IHealth. The IHealth system provides CPOE, Electronic Clinical Documentation, and Closed-Loop Medication Administration. The IHealth system was designed and built between 2013 and 2016. In March 2016, the IHealth system was activated in three sites in Nanaimo:

- Nanaimo Regional General Hospital (NRGH), an acute care facility.
- Dufferin Place, a long-term care facility.
- Oceanside Health Centre, a community primary and urgent care center in Parksville.

The implementation of the IHealth system went through many ups and downs. The following timeline presents those events in chronological order, as presented in the EY report [171]. Additionally, Figure 25 presents a high-level overview of the IHealth activation events.

- **Between 2013 and 2016:** The updated EHR system and the new IHealth functionality was designed and built.
- **February 2016:** The updated EHR system was launched across the entire Health Authority.
- **March 2016:** The IHealth advanced functionality was launched at three locations at NRGH, Dufferin Place, and Oceanside.
- **May 2016:** Just a few weeks after the implementations, users started reporting issues about the system's design and usability. Because of those issues, the emergency department (ED) in NRGH reverted to the paper ordering of medication, and the Intensive Care Unit (ICU) fully reverted to pre-IHealth paper processes.
- **June 2016:** To address those issues and concerns, the Health Authority Medical Advisory Committee (HAMAC) undertook a review and made recommendations relating to adjusting resources, improving trust in the system and associated processes, and working with clinicians to implement system improvements.

[4] https://www.cerner.com/se/en/solutions/millennium

- **Between July and November 2016:** The Nanaimo Medical Staff Association (MSA) continued to express concerns with the system and requested an external review. In response, the Minister of Health commissioned an independent third-party review by Dr. Doug Cochrane, Chair of the BC Patient Safety and Quality Council. The review has resulted in 26 recommendations that were accepted by the Island Health.
- **February 2017:** Members of the MSA passed a resolution suggesting the suspension of the CPOE functionality. The suggestion was raised with the Island Health leadership. Then, the MSA wrote to the Minister on February 9th, suggesting that if they did not receive a response before February 14th, they would stop using CPOE unilaterally at that time.

  Following this, the Ministry of Health hosted a meeting of the ministry executive, the MSA executive, Doctors of BC, the chair of HAMAC, the Island Health chief medical information officer, Dr. Doug Cochrane, and additional peer experts. This meeting did not result in a resolution. Subsequently, HAMAC held an extraordinary meeting to provide advice to the Island Health Board of Directors. The board then met with the Minister and committed to taking steps to suspend the use of CPOE.

  After a detailed analysis of how to safely and effectively suspend CPOE, the board decided not to suspend the CPOE and instead to provide additional support. The decision came from local site leadership's recommendation that the interconnection of CPOE to the rest of the EHR functionality would not allow for the safe suspension of that single component. Additionally, many other stakeholder groups, including the clinical nurse educators, the nurse informaticists, and the pediatric physicians, provided written expressions of concern to the board over the decision to suspend CPOE.
- **April 2017:** On April 21st, the Geography 2 Executive Medical Director received a letter stating that the Internal Medicine physicians would unilaterally return to paper ordering on April 27th if Island Health did not take steps to suspend CPOE prior to that date. On April 24th, the Island Health Chief Medical Officer sent a letter in reply indicating that reverting to paper orders would be counter to Island Health policies and stating that a plan was in development to provide immediate and improved support to physicians.

Internal Medicine physicians were invited to a meeting on April 26th to discuss additional support. At this time, the MSA sent a letter to its members encouraging them to support their colleagues in reverting to paper orders. Three Internal Medicine physicians briefly reverted to paper orders; their paper orders were entered into the system by other physicians during this time.

- **May 2017:** HAMAC called for a meeting to discuss the issue of physicians reverting to paper orders. HAMAC recommended that these activities should stop and that physicians should be required to enter orders into the EHR and to utilize available supports as a condition for providing services at NRGH. The Island Health board accepted these recommendations and sent a message to all staff and physicians informing them of the HAMAC recommendation and indicating that they did not intend to use discipline to resolve the issue.
- **June 2017:** The CEO of Island Health accepted a role in another organization.
- **July 2017:** The Island Health board endorsed a recommended go-forward plan, termed "IHealth 2.0". This plan consisted of two components:
    - Commitment to complete a limited rollout within what remains of the initially approved capital envelope; and,
    - Development of a comprehensive financing plan to complete the remaining scope using funding over and beyond the original $100.3M capital budget.
- **September 2017:** The Ministry of Health appointed EY to conduct this review due to the MSA's continuing concerns regarding the IHealth.

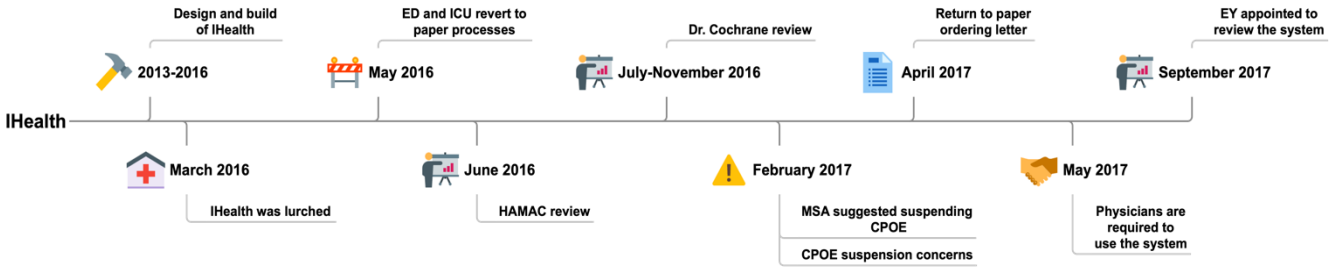

Figure 25 IHealth timeline

6.1.2 The IHealth System Status

At the time the EY review was conducted, the IHealth system's full range of functionality was in use with more than 90,000 orders entered per month by providers. Clinicians integrated the system into their practice and achieved stabilization. However, several ongoing concerns and challenges still existed. Additionally, despite the use of IHealth in most acute inpatient areas of NRGH, there were two primary exceptions:

- **ED:** Just a few weeks after IHealth activation, the ED reverted to using paper orders for ED outpatient medication orders. However, the CPOE was still being used for laboratory and medical imaging orders. For ED patients that were admitted but had not yet been transferred to an inpatient bed, orders relating to their care were written on paper. Orders relating to the care of these patients after their transfer from the ED to an inpatient unit had to be entered electronically; if these admitted but not yet transferred patients did not have any electronic orders, they were held in the ED until the receiving service entered electronic orders.
- **ICU:** The ICU reverted to full paper processes shortly after activation.

EY reported 47 challenges/observations/issues with the IHealth system, such as the lack of stakeholders' engagement, inadequate training and communication, the poor state of readiness of both people and processes, the poor choice of implementation approach, and many organizational and functional issues.

In the next sections, I will focus on the issues related to change management, including organizational culture and readiness. I will consider the reasons behind those issues and how the UCCM process could have helped to avoid those issues.

6.2. The IHealth System Issues

The report organized the key observations into seven areas: progress against the Cochrane recommendations (4 challenges), functionality and usability challenges (8 challenges), risks to patient safety (4 challenges), culture and governance (12 challenges), readiness (5 challenges), benefits realization (7 challenges), and project finances (7 challenges). Some of those areas are out of the thesis scope. So, the list of issues presented in this chapter is not inclusive. Below, I will consider each area and spot observations related to aspects

covered by the UCCM process. The goal is to spot where the project failed to consider change management and UCD aspects.

- **Cochrane recommendations**

  EY observations on the progress against Cochrane recommendations emphasize the importance of *communication* to avoid the uneven perception of progress across different stakeholders. Stakeholders must be informed about the solutions that are in place to meet the Cochrane recommendations. They also must be updated about the implemented improvements in order for them to feel and accept those improvements. The effectiveness of *users' engagement* has been realized by Island Health through the invitation of physicians to participate in revalidation work teams.

- **IHealth system-related challenges**

  The observations of this area consider technical and usability challenges with the IHealth system. Those challenges are out of the thesis scope. However, those challenges provide important lessons that the IHealth can benefit from when going forward with IHealth 2.0.

  - *Users' engagement* and consultation prior to the actual activation would have helped to mitigate some of the raised issues or even dealt with them quickly afterwards.
  - The same applies to *leveraging the experience of peer organizations*. Organizations that have implemented similar systems have experienced similar issues. The Island Health could have benefited from peer organizations' experience and resources to either avoid those issues or even dealing with them quickly after activation.
  - *Analyzing workflow* to improve the IHealth system fit, mitigate the need for workarounds, and minimize the system's negative effect on productivity.
  - Providing *ongoing support and training* to prepare users for the system improvements.
  - The CPOE system increases the time and effort required by clinicians to complete orders compared to paper-based orders. Hence, decision-makers should inform clinicians about that in advance to *manage their expectations.*

- **Risks to patient safety**

  Risks to patient safety challenges are out of the thesis scope because they are related to the system itself. However, this category includes some issues related to change management and UCD approaches in some way. Considering lessons learned from those issues is necessary for future activation of the system.

  - Currently, users have the perception that the system is less safe than the old paper-based processes. The Island Health should make efforts to 1) understand the roots of such perception, 2) address those roots and concerns, and 3) change that perception by communicating that the benefits of implementing the IHealth system significantly outweigh the risks presented by it. Moreover, there is a high possibility that future users at other locations have the same perception. So, effective *analysis and addressing of those perceptions* is a must to ensure the success of future activation of the system.
  - *Users should be engaged* to see that those events are taken seriously, and changes are made to address them. The project team should plan processes for tracking, investigating, and communicating the resolution of reported risks with clinicians.
  - Moreover, *ongoing support and training* are necessary to eliminate the risk of not knowing how to use the system, precisely when new improvements have been introduced. Providing clinicians with ongoing support is essential to mitigate the likelihood of going back to the paper process, which can be a source of risk to safe patient care.
  - In addition to ongoing support, a thorough *analysis of the context and workflow* where the system will be used is required to integrate the system correctly and reduce patient safety risks.

- **Culture and governance**

  Despite the importance of addressing the system and patient safety issues, the organizational culture and governance issues are more critical. It is impossible to address the IHealth system issues without addressing the cultural issues first [171]. Hence, this part's focus will be on those challenges and their cause and effect on users more than on the learned lessons.

The shortcomings of the implementation process of the system caused much resistance from users. It also caused much tension and distrust between users and leadership. Numerous issues have initiated that *resistance and distrust*:

- The Island Health used a "win at all costs" approach to implement the IHealth system. Their focus was on the progress of implementation and not on the quality of the system or the acceptance of users. Such a poor approach left the users feeling that their objections and feedback were not taken seriously by leadership.
- The Island Health was moving fast with the implementation ignoring users' opinions and preferences for a slower approach. The board opted for a "big bang" implementation to activate all three functionalities concurrently at the three sites. Consequently, a significant amount of change is forced in a short amount of time.

In addition to the implementation issues, several other issues caused *users disengagement, frustration, change fatigue, low morale, and negativity*.

- The reasons behind users' resistance have been ignored, leaving them disengaged.
- The lack of positive progress regarding the system improvements.
- The inadequate amount of provided support for users to adapt to the improvement process.
- The poor responsiveness to issues raised by users regarding the system functionality.
- The many challenges that delayed the system activation process have led to frustration and a lack of confidence in its success.
- The frustration was not limited to users, as it expanded to include members of the IHealth project delivery team. That frustration has led to a loss of experienced team members.

Besides the cultural challenges, several governance challenges affected the IHealth project.

- The first and most concerning issue is that the IHealth project leadership team *was not physician-led*. Also, it did not include clinical leadership.
- Furthermore, the IHealth project team did not sufficiently *engage local clinicians* at NRGH.
- Some key leaders of the Island Health executive were not aware of some aspects of the IHealth project or the amount of resistance to the project.
- Leadership was not effective in addressing users' concerns.

- **Readiness**

  While all the above observations consider the IHealth system status at the time of the report, the readiness observations consider the preparation before the system activation and its consequences after activation. The report states that the system was activated without appropriate preparation, specifically at the NRGH. Also, several identified challenges resulted from the approach the Island Health used to implement the system. The following is a list of aspects that were not well-thought-out before the system activation.

  - *Training:* The used approach to train users, specifically physicians, was insufficient and ineffective because:
    - The training was not mandatory.
    - The training was only one session that lasted for 8 hours.
    - The training was done using a training version that was significantly different from the actual IHealth system.
    - There was no flexibility in times and selections of training.
  - *Resources:* There was an apparent lack of support resources, as well as a lack of experienced staff to provide support during and after the activation.
  - *Expectation management:* Expectations from the project were set too high with users despite the poor preparation pre-activation.
  - *Context and workflow analysis:* Users reported that prior to activation, efforts to analyze and understand the context and clinical practice were insufficient to prepare them for the coming change. Instead, a significant change to clinical practices was forced on day one of activation.

- *Implementation approach:* The IHealth system was implemented using a "big bang" approach. Three advanced functionalities (CPOE, closed-loop medication management, and clinical documentation) were implemented simultaneously. That produced too much change at once, affecting the organization's ability to prepare and adopt change effectively.
- *User engagement:* The issues, as mentioned earlier, reflect the poor engagement and consultation with users during the planning and activation phases of the system.

- **Benefits realization**

  The IHealth system has a good business case and benefits that are in line with peer organizations. The problem is that the identified issues have extended the stabilization period to 18 months, which is too long compared to similar projects. Such a long time caused only a small number of the benefits to be measurably realized, which triggers frustration and distrust of the system among end-users.

- **Project finances**

  Observations related to the current financial state of the IHealth system are out of the thesis scope. However, an ineffective change management plan and user disengagement resulted in unnecessary costs that consumed the project budget.

6.3. Application of the UCCM Process

"…a number of the challenges we identify are a result of the approach that Island Health used to implement the system" [171]. This sentence reflects the role of the implementation preparation and approach on the success of the IHealth system.

Many of the spotted issues with the IHealth project resulted from poor management, including poor change management and weak leadership. The UCCM process is a promising approach in such context to minimize issues related to the change management and users' acceptance of the system.

The UCCM process is a change management planning tool that aims to prepare the users for the change that comes with the CPOE implementation, by making them the center of the change. Hence, when applying the UCCM process to the IHealth system, the goal is to show only how the UCCM process could help with the change management issues.

Many of the reported issues are out of the UCCM process scope. Nevertheless, the observations presented in the readiness section are the most related ones to the UCCM process. Below, I will explain how decision-makers could have used the UCCM process to address the issues. I will also consider what was done well in alignment with the UCCM process. Each step of the UCCM process will be discussed according to the IHealth system issues that could be avoided by applying that step. Some issues can appear in multiple steps. Table 17 provides a summary of the level of contribution each UCCM step/sub-step would have had on the success of the IHealth project along with justification.

S1. Building motivation to change

The Island Health has built a convincing business case that was reasonable, achievable, and aligned with global trend and peer Canadian organizations. The ultimate goal of the IHealth system is to provide a more coordinated care model that is integrated across the continuum. The high-level business case for IHealth was built on several drivers:

- Reducing medication errors and adverse drug events;
- Eliminating the information gaps and reducing safety risks presented by the hybrid electronic/paper system in place at Royal Jubilee Hospital; and
- Use evidence to improve outcomes, quality, and safety, and support an integrated care model.

Additionally, The Island Health has identified 15 benefits that were grouped into five categories (a detailed list of the benefits can be found in Appendix C):

- Category 1: Clinical Quality and Safety
- Category 2: Patient-Driven Care
- Category 3: Provider-Supportive Care
- Category 4: Health System Efficiency and Sustainability
- Category 5: Population Health

For the leadership engagement, there were no specific details on how the leaders were engaged. However, some reported points indicate that there are some leadership issues. At the time of the IHealth system activation, Island Health was moving from a programmatic governance model to a regional governance model, which left several key medical

leadership positions unfilled or newly filled. Hence, the required level of leadership engagement and support may not have been achieved. Another major issue was that some Island Health executive leaders were unaware of some critical aspects of the IHealth project.

The result of those issues was that leadership was not effectively connected to the system causing distrust between users and leadership.

In conclusion, the IHealth project did not have issues building motivation because of its strong business case; however, its leadership's weakness has affected how to gain the end users' trust in the feasibility of the system.

S2. Forming a Change Committee

The report mentioned the IHealth project team several times. It seems that the team was in charge of building, designing, and implementing the system. It is not clear whether there was another team dedicated to managing the change process. The report cited other teams such as the IHealth project delivery team, IHealth project leadership team, and IHealth project controls team.

Besides the possible lack of a change management team, the concern with the existing project team is that it was not physician-led, did not have formal representation from the clinical leadership, and did not have sufficient representation from local stakeholders.

Establishing a change committee/team responsible for managing the change process would have helped the IHealth project team engage a mixture of different stakeholders and listen to their ideas to make more informed decisions about change management. It would have helped in addressing users' concerns before, during, and after system activation.

S3. Creating a vision

The IHealth project vision is to provide an integrated clinical information system that spans the entire care continuum. Nevertheless, the project still needed a change vision that provides a clear picture and timing of how and when the change would be implemented. Users' perceptions of the future may have been confused and unclear, affecting their acceptance and interest in the system.

Creating a compelling vision would have helped the project team picture the promising future to the users to get them motivated and engaged. They would have planned more effectively for how to achieve the objectives with less dissatisfaction from the affected users.

S4. Analyzing context and workflow

From reviewing the IHealth system challenges, it is noticeable that the quality of the conducted analysis of the context and workflow was insufficient. Many of those challenges would have been avoided with a better understanding of how things were done before the system activation and how they would have been affected after activation.

After the system activation, the ED and ICU at NRGH decided to suspend the use of the CPOE either entirely or partially, and returned back to paper-based processes. That is because the project did not consider the complexity and uniqueness of the two departments' processes and workflows.

Users were not sufficiently prepared for the change due to the lack of reasonable efforts to analyze and understand the context and clinical practice. In their efforts to make the system work, users had to create many workarounds because the system would not integrate appropriately into the existing workflows. The danger with workarounds is that they affect clinicians' productivity and could increase risks to patient safety.

Additionally, an effective analysis would have shown a shortage of resources and experienced staff for providing support during and after the activation. It would have also exhibited that the size of the planned change was enormous and needed to be implemented using a slower pace.

Finally, the substantial evidence on the importance of the analysis is in the report observation that "Existing challenges with the culture at NRGH also made this site a poor choice for the first activation" [171]. A useful analysis would show the challenges with the selected location, so decision-makers would have either delayed the activation until challenges were addressed or chosen another location. Giving better attention to understanding the context where the system will be implemented is indispensable for the implementation success despite the associated cost.

S5. Choosing champions and superusers

Champions and superusers were not mentioned in the report. Although this does not imply the absence of the two roles in the project, there are several indications that these roles were not providing what is expected from them.

Users kept reporting the same issues over and over again in many cases, even if these issues had been solved. This indicates the absence of a sufficient number of people playing the role of champion. The presence of clear and sufficient champions in the IHealth project would have contributed to reducing some of the users' resistance. That could have been done by addressing their concerns quickly as they rose and distinguishing between concerns that resulted from the system weakness or from users' fear. Even after activation, the champion's role was essential in communicating the improvements to the system to the users. Additionally, champions would have been the perfect vehicle to deliver users' opinions and feedback to the decision-makers.

After activation, users faced several issues when using the system. There was an insufficient number of staff experienced in the IHealth system to provide the necessary support. This indicates the absence of a proper number of superusers. The presence of sufficient superusers would have helped users use the system by answering their questions and giving timely help. Having superusers would have helped raise issues regarding the system functionalities sooner. All in all, effective superusers have a significant influence on reducing frustration and increasing productivity among users. So, instead of spending their time trying to understand how to use a specific function, clinicians can ask superusers, quickly get answers, and get back to their patients faster.

S6. Analyzing and identifying users and their requirements

There is no indication that users' requirements have been considered when planning for the implementation. A lot of the reported challenges resulted from ignoring user needs.

It has been reported that several usability issues with the IHealth system existed because users were neither engaged nor consulted prior to activating the system. This means users' requirements, perceptions, and expectations were not considered. The same diagnostic applies to other issues related to change management and readiness.

Overlooking users' requirements caused resistance and dissatisfaction among users. For example, the provided training was planned without considering users'

requirements and preferences. The result was inadequate training and unprepared users. Providing more flexible training may seem costly. However, the result of not providing sufficient training is an additional cost for creating new material and re-training users again, as well as additional time needed to do all this and possibly increased risks to patient safety.

Moreover, users preferred a slower approach to activating the system, yet the project team ignored that preference and chose a more aggressive approach, causing much resistance due to the size of the change. A leadership that is not taking users' requirements and concerns seriously enough causes a culture of frustration and dissatisfaction.

The same thing applies for users' perceptions, concerns, and expectations. In the IHealth project, expectations were set too high with end-users. After activation, users realized that the system was complicated and required more time to use than the paper-based process. Being open and honest about possible trade-offs would have prepared the users more effectively. Additionally, analyzing users' perceptions would have helped the project team detect users' negative perceptions of the system's safety. The majority of the users perceived the IHealth system as *less* safe than the paper-based processes. Knowing that such perception exists can incite the project team to investigate its roots and address it or find a channel to explain how the benefits of the system outweigh its risks.

Another issue related to this step is the users' inventory information. After activation, interviewed users believed that there was a shortage of staff experienced in using the system or implementing change. That shortage affected the quality of the provided support in the immediate period after the activation.

Addressing users' concerns, perceptions, and requirements during the system implementation gives them a sense of ownership and responsibility towards the system's success. This helps manage their expectations and minimize the number of surprises. Using the "User requirements survey" (presented in Appendix A) will help better understand the system's users.

S7. Considering previous experiences

While reviewing the IHealth system, EY consulted with a clinical panel that involved digital health specialists and physician users from Canadian organizations that have successfully implemented a similar system using the same vendor. Besides, EY researched similar

EHR projects in other Canadian and international jurisdictions. It appears that the IHealth project team has not benefited much from previous experiences of peer organizations in planning for their system implementation. A significant portion of the issues has been experienced by peer organizations with similar systems. Had the IHealth project team exploited those experiences, they would have avoided many of the same issues. For example, based on their experience, Canadian peer organizations advised against implementing the system using a big bang approach. Instead, they phased implementation of functionality, starting with CPOE and closed-loop medication, followed by clinical documentation. Using a phased implementation approach enables organizations to appropriately perform design, testing, and training. This also gives users more time to adapt to change and learn at a slower pace. In his assessment of Island Health's EHR strategy, Dr. Denis Protti warned Island Health from doing too much too quickly. He noted that "the fallout from big bang approaches can be severe and traumatic" [171].

Another example is using hybrid systems in EDs. Peer organizations had used mixed electronic/paper processes to operate ED in order to handle the unique process and complex workflow. In the IHealth system, the goal was to move both the ED and ICU fully to EHR. The result was that in just a few weeks after activation, the ICU had entirely reverted to paper, and the ED reverted to paper medications orders and kept using the remaining IHealth functionalities. The lesson here is that the peer organizations' experiences implied that the use of the big bang approach was not suitable for the IHealth project. Additionally, it was complicated to implement a fully electronic process in ED, and a hybrid system would have been a better option [171].

Considering previous experiences also includes learning from experience with previous change projects. What is alarming in the IHealth project is that the team was planning to use the same implementation approach for the rest of the project. The Island Health board has approved the IHealth 2.0 rollout plan. The plan involves activating all three pieces of advanced functionality concurrently in all sites despite their bad experience with the "big bang" implementation and user requests for a slower, phased option. Additionally, the IHealth 2.0 rollout plan ignores the fact that the first phase of the activation is still in a stabilization state with pending reviews and ongoing public concerns [171]–[173]. Moreover, the available funding is insufficient to continue with the activation.

In preparation for the IHealth 2.0 rollout plan, the project team should consider users' perspectives and concerns that can be affected by what they have heard from their peers or media about the first phase of the IHealth system activation, including:

- The system is complicated and hard to use.
- Using the system has a negative effect on productivity.
- The system is less safe and involves risks to patients.
- Users' feedback is not taken seriously by leadership.

S8. Developing the change management plan

Due to the lack of important details about the project and users, I cannot develop a complete change management plan. However, I will include recommendations on planning for each sub-plan based on what has been learned from the IHealth project.

S8.1 Goals, approach, and timeline

Based on the report, there was no major issue with the goals identified by the IHealth project team. The goals were reasonable and achievable. However, there is no data about the timeline to achieve those goals.

For the implementation approach, it is best to consider a phased implementation to activate functionality in stages, starting with CPOE and closed-loop medication, then finally, clinical documentation.

S8.2 Workflow optimization plan

Based on the analysis of the current workflow and clinical practices, the workflow optimizations should be planned. Since the project targeted the acute-care facilities, special consideration should be given to the ED and ICU unique processes and complex workflows.

S8.3 Resistance plan

In the IHealth project, users' resistance resulted from system complexity, ignoring their needs, disengaging them from the decision process and their perceptions about the system. Paying more attention to those reasons and planning on addressing them might help mitigate a lot of the resistance.

Additionally, considering the use of a hybrid system in the ED and ICU could be a way to address the resistance issue in those departments.

S8.4 Leadership engagement plan

Leadership engagement was not effective during the system activation. There are some trust issues between users and leadership. To overcome these issues, leadership engagement should be planned carefully. The plan should cover how to consider users' feedback, address their concerns, and be aware of the different aspects of the system and its issues. The plan should also cover how to engage different leaderships such as clinical leadership.

S8.5 Measures plan

The IHealth project team has a full measure plan in place. The plan contains 15 benefits across five categories, with 55 associated process and outcome measures. Appendix C presents the benefits and associated measures. According to experts, the plan is reasonable.

S8.6 Short-term wins, rewards, and recognition plan

The importance of planning for short-term wins was raised with the long period of uncertainty. The long period affected the ability to realize most of the anticipated benefits. Due to that, users could lose their trust and interest in the system.

To keep users motivated, the project team should plan for short-wins and how to celebrate those wins. For example, the report stated that more than 90,000 orders were entered per month by ordering providers. The team could have planned for a celebration when the number of orders reached 10,000 orders per month. The planning should also include how to recognize and rewards those who made extra efforts.

S8.7 Training plan

In order to create a good and effective training plan, the following points should be considered:

- Training should be made mandatory for everyone who will be using the system.
- Trainees should be compensated for their time.
- There should be flexibility in training times.
- The training plan should include different techniques of training to accommodate a large number of needs.
- The training should be done using a training version that is very similar to the actual IHealth system.
- The plan should consider long-term training for system improvements.

- The plan should consider the users' requirements and preferences of training. The "User Requirements Survey" (presented in Appendix A) is a great tool to collect that information.

S8.8 Communication plan

Despite the scarcity of information about the communication methods used in the project, there are several indications that the communication approach was insufficient to inform users about the improvements to the system. It is essential to use every possible chance to update users regarding the changes to the system. There should be two-way communication channels to receive users' concerns and reply to them how they have been addressed. The plan should also consider how to communicate the system benefits and achievements using different channels and tools to reach all users. Consulting users on how they prefer to be communicated help planning for better communication. The User Requirement Survey (presented in Appendix A) is one option that assist in identifying users' needs and requirements when it comes to communication.

S8.9 Support plan

The main lesson about support planning is ensuring enough support resources, mainly in the immediate period after activation, is in place including having enough experienced and skilled staff.

S9. Evaluating the change plan

After creating the change management plan, the latter should be presented to the whole project team, leadership, and representatives of the users (or all users), if possible, to obtain their perceptions and feedback on the plan. Then, there is a need to update/adjust the plan according to the received feedback.

A good number of the IHealth issues have resulted from the poor change management approach that have been used in the project. Although it is not obvious which approach have been used, evaluating the plan by users, and incorporating their feedback before the implementation would have improved the change management plan and saved the project. Consulting users on the change management plan would allow decision-makers to see things from users' perspectives and adjust the plan accordingly.

S10. Monitoring and evaluation

After the system implementation, Island Health should monitor the progress to make sure that changes are institutionalized, and the benefits are realized. In the first task, *the change management plan evaluation*, the formative evaluation can be achieved by collecting and analyzing users' feedback after each training session or communication message. The summative evaluation can be done by distributing the "User Satisfaction Survey" (presented in Appendix B) to users and then analyze the results. In the second task, *the IHealth system evaluation*, the project team can use the process metrics (presented in Appendix C) and/or create a user acceptance and satisfaction survey.

S11. Providing ongoing support

The project team should continue providing support after the project completion. That includes ongoing training, addressing concerns and improving the system's usability. It is so important to inform users about available support resources. Despite all the challenges and scarcity of resources, the IHealth project team has provided an acceptable amount of ongoing support after the implementation. A lot of Cochrane recommendations have been implemented successfully.

Lessons learned from the IHealth system experience are the significance of communicating improvements to the users to show them how valuable their satisfaction is and the importance of assigning enough resources to keep supporting users to maintain the achieved progress.

Table 17 Summary of the level of contribution each UCCM step/sub-step would have had on the success of the IHealth project

			Contribution level	Reasons
UCCM process steps	S1			The IHealth project had a strong business case; however, its leadership's weakness has affected how to gain the end users' trust in the feasibility of the system.
	S2			The IHealth project should have had a change committee that had sufficient representation from local stakeholders and clinical leadership.
	S3			Users' perceptions of the future may have been confused and unclear, affecting their acceptance and interest in the system. Hence, in addition to the project vision, the IHealth project needed to create a change vision that provides a clear picture and timing of how and when the change would be implemented.
	S4			Building on the discovered challenges in the IHealth project, the quality of the conducted analysis of the context and workflow was insufficient. The analysis missed much needed details.
	S5			Many issues indicate the absence of champions and superusers. They may have existed but, if so, they were not providing what was expected from them.
	S6			All indications led to believe that users' requirements, perceptions, and expectations were not considered. Overlooking users' requirements caused resistance and dissatisfaction among users. UCCM's *User Requirements Survey* would have been an excellent tool to use to perform this task.
	S7			Considering peer organizations previous experiences while planning for the IHealth project would have saved the project from a significant portion of the issues. Moreover, the IHealth project team is planning to use the same implementation approach for future activations, ignoring all warnings.
	S8	S8.1		It is best to consider a phased implementation to activate functionalities in stages, starting with CPOE and closed-loop medication, and then clinical documentation.
		S8.2		Special consideration should have been given to the ED and ICU's unique processes and complex workflows.

			Contribution level	Reasons
		S8.3		There was no clear plan on how to manage users' resistance. Paying more attention to resistance reasons and planning on addressing them could have helped mitigate much of the resistance.
		S8.4		The absence of efficient leadership engagement has caused much damage to users' trust on leadership and the project.
		S8.5		The IHealth project team had a full and reasonable measure plan in place.
		S8.6		The long period of uncertainty showed the importance of having a short-term wins plan to keep users motivated.
		S8.7		The IHealth project training plan needed a major revision to achieve its goals.
		S8.8		The IHealth project communication plan needed a major revision to achieve its goals.
		S8.9		The provided support has helped solving a good number of the issues. However, the IHealth team should have planned more efficiently to provide enough support resources.
	S9			A good number of the IHealth issues have resulted from the poor change management approach that has been used in the project. Consulting stakeholders would have highlighted change management plan issues before the implementation.
	S10			The IHealth project had a reasonable set of process metrics that could be used to evaluate the IHealth system. However, the used change management plan had not been evaluated. Additionally, a tool such as UCCM's *User Satisfaction Survey* should have been used to evaluate users' satisfaction level with the change management approach.
	S11			Despite all the challenges and the scarcity of resources, the IHealth project team has provided an acceptable amount of ongoing support after the implementation. However, the team still needed to plan efficiently for the support resources.

Much help Some help No help

6.4. Discussion

After analyzing the IHealth system challenges as presented in the EY report, I found that many of those challenges resulted from poor management, specifically change management. The system was designed and activated based on what the management *thought* was best, not on how the users would perceive it. There was an apparent lack of users' engagement in planning for the system implementation. Users were forced to use the system with little preparation for the change and insufficient training and support, causing much resistance and attempts to suspend the system's use altogether, particularly the CPOE functionality.

The UCCM process would have helped the project team develop a more effective change management plan to reduce resistance and increase acceptance and satisfaction. Moreover, the use of the UCCM process would have saved the IHealth system from facing the following issues:

- ***Uneven perception of progress:*** Despite the team efforts to improve the system and address its issues, users still reported similar issues as critical due to poor communication.
- ***Compromising patient safety:*** Due to many challenges after activation, some areas at NRGH reverted to paper-based processes either entirely or partially. Using a hybrid system without proper planning can cause serious issues that may affect patient safety.
- ***Frustration among users:*** The reverting back to paper-based processes and the continuously rising issues caused experienced users to retire or move to other organizations.
- ***Distrust between users and leadership:*** Users felt that the leadership goal was to declare success without considering their opinions. That led to a lack of confidence in the ability to have an effective system.
- ***Growing opposition to the continuation of the system:*** Users were profoundly dissatisfied with the IHealth system's state, causing them to oppose the continuation of the system actively.

- ***Delaying future activations***: The possibility of going back to paper or removing functionality has created a state of uncertainty that made it difficult for the organization to move forward with the rollout to other locations.
- ***Diverting resources:*** Due to constant changes to priorities, many project resources have been diverted to address the rising challenges. For instance, the project team had assigned resources to build reports and measure benefits metrics. However, those resources have been diverted to reporting on system use and adoption metrics to support the system's stabilization. That affected the team's ability to realize the project benefits and communicate those benefits with users.
- ***Long stabilization period:*** Compared to peer organizations, the IHealth system stabilization period was longer than expected. After 18 months of activations, many critical issues persisted.

In addition to avoiding the problems mentioned above, using the UCCM process would also have saved some costs on the project budget. Applying the UCCM process may seem costly and demanding in terms of time and resources. However, as shown in the IHealth case study, there are also major costs to insufficient planning and execution, and the UCCM process can help save such projects from unnecessary costs.

How would the UCCM process save costs?

The IHealth system faced several financial issues. Many project costs could have been saved had the project team used a proper change management plan, such as the UCCM process. The following is a list of costs that could be avoided. It is not exhaustive as the EY report did not discuss costs to patients and other stakeholders.

- The cost of reverting to paper-based processes.
- The cost of workflows and processes revalidation.
- The cost of the extended stabilization period.
- The cost of diverting important resources to address challenges.
- The cost of the time spent in fixing issues.
- The cost of losing experienced staff.
- The cost of third-party reviews.
- The cost of rebuilding trust and reputation with the users and the public.

It is much cheaper to plan effectively in advance than fixing issues later. Table 18 explains the activities that cost the Island Health $17.7M outside the original baselines forecast. Bedsides all those unnecessary costs, the initial budget envelope will not be able to cover the deployment to the remaining locations.

It is worth noting that using the UCCM process would not solve all of the IHealth system challenges. The UCCM process considers issues related to change management only. Solving such issues would save the project but would not guarantee its success regarding other challenges. In particular, the IHealth system faces several usability and cultural issues that would not be solved by the UCCM process.

Table 18 Island Health estimated spending outside of the original baseline forecast [171]

Activities	Description	Cost
New EHR foundation build and data migration	Decision was made post project initiation to build the advanced EHR capability on an updated EHR platform, which involved additional design/build activities for the foundational EHR capabilities, and significant data migration efforts.	$7.5M
Extended clinical testing and workflow validation	Due to delays in the foundational EHR design/build, Integration Testing activities were completed in parallel with final design/build activities. This required six Integrated Testing events (including one specific for NRGH) instead of two events as planned in the baseline schedule.	$3.0M
NRGH site stabilization	Efforts to stabilize the site following the HAMAC review and pursue different EHR support models.	$6.0M
Third party review and response	Dr. Doug Cochrane was engaged to complete a Third-Party Review of IHealth. Considerable efforts were dedicated to information gathering and follow-up activities (23 resources at 65%).	$1.2M

6.4.2 Report's Recommendations and the UCCM Process

At the end of the report, a list of 9 recommendations has been provided to support Island Health in moving forward with the IHealth project.

- **Recommendation 1:** Move forward with IHealth, clearly articulate this decision, and communicate the expectation that all stakeholders will put their effort towards constructively working through issues towards a better system.
- **Recommendation 2:** Fully investigate all safety concerns related to IHealth and address the perception that the system is less safe than the previous paper processes.
- **Recommendation 3:** Stabilize IHealth at NRGH before moving forward with other sites.
- **Recommendation 4:** Ensure that the right leaders are in place in all levels at Island Health to move forward with IHealth and work towards building a culture of respect and trust.
- **Recommendation 5:** Review the governance structures for the IHealth program as well as Island Health more broadly to confirm that they are able to function effectively and contain appropriate linkages with key stakeholders.
- **Recommendation 6:** Ensure that all future activations are contingent on a detailed readiness assessment and that sufficient training, support, and change management resources are in place.
- **Recommendation 7:** Develop a realistic financial and resource forecast that recognizes the change management, training, and support requirements for moving forward.
- **Recommendation 8:** Review and confirm a funding model necessary to cover all operational impacts of and requirements for a successful delivery of the re-baselined plan.
- **Recommendation 9:** Pause IHealth 2.0 plans and develop a detailed, comprehensive, and realistic plan to move forward.

Most of the recommendations are about how to move forward and mitigate the consequences of the observed issues. The recommendations do not consider what has been done in the past or how it was supposed to be done. Table 19 presents the recommendations that are in alignment with the UCCM process steps.

Table 19 The UCCM process alignment with the report's recommendations

Report's recommendations	UCCM process

Recommendation 1	• Clear *communication* with stakeholders about:
	  o The decision to move forward with IHealth;
	  o The reasons behind the decision; and
	  o Clearly set expectations.

Recommendation 2	• *Communicate* the findings and recommendations back to the relevant stakeholders in a timely manner. • Provide adequate *resources* and funding to *support staff* • Provide ongoing quality improvement *training* and skills development. • Address the *perception* that the system is less safe than the previous paper-based processes. • Leverage *peer organizations' experience* in addressing the risks presented by the hybrid processes in the ED and ICU.
Recommendation 3	• Solicit and incorporate best practices from *peer organizations.* • *Involve MSA and other staff* when identifying and resolving critical issues. • Continue *monitoring and evaluating* the system until required measures are met. • *Provide ongoing support* to stabilize NRGH.
Recommendation 4	• Review the current *leadership* roles at all levels to foster a culture of trust. • Ensure effective and respected *medical leaders* are in place at the clinical program level.
Recommendation 5	• *Form a change committee* that involves representatives of different groups of stakeholders.
Recommendation 6	• Take all possible steps to ensure that future sites are *fully prepared before IHealth system activation.*
Recommendation 7	• *Consider the experience* from the initial deployment at NRGH when planning for future activation. • Gather *input and gain agreement from relevant stakeholders* on the newly proposed implementation strategy.
Recommendation 8	• Out of scope.

Report's recommendations	UCCM process
Recommendation 9	• *Consider the experience* from the initial deployment at NRGH and peer Canadian organizations. • *Consider the recommendations* provided by third parties. • *Consider what changes* need to be made from a people, process, and technology standpoint • *Develop a detailed, comprehensive, and realistic plan to move forward.*

Recommendation 6 focuses on preparing other sites for future activations and developing a robust plan (change management plan) before starting the activation process. This recommendation aims to prepare future locations for the coming change. This includes:

- Providing mandatory and compensated training and effective support through qualified and expert support personnel.
- Provision of sufficient support personnel to provide elbow to elbow support.
- Gaining local clinical program leaders' agreement in their program's readiness for activation.
- Conducting or evaluating readiness assessments with the assistance of an independent body, such as HAMAC or a panel of experts from peer organizations.

Additionally, recommendation number 9 calls for the development of a detailed, comprehensive, and realistic plan to move forward with future activations. The recommendation focuses on leveraging previous experiences and considering the change. The UCCM process will provide the perfect guide that will help the IHealth implementation team planning for future change management.

In conclusion, comparing the UCCM process with the report's recommendations shows that the UCCM process considers critical aspects, specifically in terms of change management, that can affect the CPOE implementation. On that aspect, the UCCM process is more detailed and goes beyond the recommendations of the report. Furthermore, the report's recommendations are broad and not specific to users. On the other hand, the UCCM process is more detailed and considered the users in every step.

6.4.3 Limitations

The system under investigation introduced three functionalities (CPOE, Clinical Documentation, and Closed Loop Medication Administration). The report did not distinguish between the three functionalities regarding the observations, i.e., it was not about the CPOE system alone. However, it was implied that the use of CPOE is the basis of the majority of challenges.

Most of the reported issues are related to one location (NRGH). However, it is not clear whether the other two locations were facing similar issues or not. Moreover, there is no classification of issues based on location.

There is insufficient detail about the used approach for change management planning in the project. It has been mentioned several times that change management activities are considered in the project finances. However, no details were provided about the actual plan.

The report is missing many important details regarding the project and sites where it is implemented. Because the report is reviewing the project's current status, it is not including information about the project management or the users who are using the system.

6.5. Chapter Summary

This chapter presented a case study that considers a report on the status and challenges of Island Health's IHealth EHR. It presented the issues that the system faced because of its implementation and change management processes. In addition, it showed the potential usefulness of using the UCCM process in avoiding many of those issues.

In addition to its role in preparing the users and organization for change, the UCCM process will help such projects avoid preventable expenses.

In the next chapter, I present the significance of the study and its impact. In addition, I discuss related work as well as the main limitations of this work and threats to validity.

Chapter 7. Discussion and Limitations

This chapter discusses the significance of this study and its expected impact on healthcare. It also considers the most closely related work and how it differs from this study. Lastly, the chapter concludes by presenting challenges, limitations, and threats to the validity of this thesis.

7.1. Significance of the Study

The UCCM process was developed to provide a change management plan that is user oriented. The fundamental principle is that the clinicians who will be affected by the introduction of the CPOE system are the ones who can provide the most relevant insights.

The UCCM process was developed with the help of healthcare informants based on a real problem to complement project management in CPOE projects. It provides managers and decision-makers with the necessary knowledge to develop a change management plan based on a comprehensive understanding of users, workflow, and context while fitting within project constraints, e.g., time, budget, organizational culture, etc.

This study's significance to both the fields of change management and HIT is that it changes the traditional understanding of how to plan and introduce change when implementing healthcare technology. The study incorporates change management and UCD approaches to introduce an iterative development of a change management plan that is user-centered and user-led. It allows different users to review and actively provide input into the plan design and redesign, either directly or indirectly.

7.2. Expected Impact of the Study

The professional application of the UCCM process during the CPOE implementation offers positive impacts on healthcare organizations implementing CPOE systems, as well as on managers, clinicians, and patients.

7.2.1 Impact on Healthcare Organizations

Many physicians describe CPOE implementation as one of the largest changes in clinical practice and workflow in a generation [116]. Besides, a CPOE implementation is an expensive investment decision for a healthcare organization. Even implementing "off the shelf" CPOE packages is costly because of the significant amount of customization this requires for each organization [174], [175]. However, clinicians' resistance to the use and adoption of the CPOE system would lead to a considerable loss for organizations that opt to make the CPOE investment. Lorenzi and Riley [143] mentioned that motivated people can make a mediocre system work fairly well. On the other hand, unmotivated people can make a technologically excellent system fail if they resist the system implementation.

Developing a CPOE change management plan using the UCCM process will help healthcare organizations identifying and preventing issues that would affect users' acceptance of the CPOE system early. Identifying and solving users' resistance will allow hospitals to take full advantage of the new CPOE system to improve care and produce its intended benefits. The UCCM process will also encourage utilizing the system to its fullest extent, which will in turn help reduce errors, improve clinical practice, and save costs and time in the long run.

7.2.2 Impact on Clinicians

The successful application of the UCCM process will have a significant positive influence on counteracting the effects of resistance to change. It will give users a sense of ownership of the system and mitigate their perception of the new system's threats and risks. Additionally, the UCCM process will help develop effective communication and training programs for clinicians before the CPOE implementation.

7.2.3 Impact on Managers

When implementing a new system such as CPOE, managers and other decision-makers will face a range of challenges. Most of the time, they need a guide on how to start the change, how to prepare users for the change, and how to convince users to accept that change.

The application of the UCCM process will give users the opportunity to participate and share their opinions. As a result, managers will be averted from users' objections that the system was implemented without consulting them or considering their needs. Therefore, managers will have more time to plan and deliver results instead of addressing users' complaints. Involving users from the beginning of the change management planning will give them a sense of ownership and will encourage them to put more effort for the sake of the system's success.

7.2.4 Impact on Patients and Healthcare System

The social significance of the UCCM process is its potential role in improving healthcare systems and patient care. The contribution of the UCCM process in improving the acceptance and usage of the CPOE system will lead to achieving its intended benefits, such as lowering medical costs to the patients and the healthcare organizations, streamlining clinical workflow, and improving patient outcomes.

7.3. Related Work

The result of the literature review (in Chapter 3) shows no evidence about using UCD during a CPOE system's implementation process (Section 3.4). In addition, using UCD in the change management context was only discussed in the gray literature. However, Edward's thesis on *Electronic Medical Records & Computerized Physician Order Entry: Examining Factors and Methods that Foster Clinician IT Acceptance in Pediatric Hospitals* has considered combining UCD and change management approaches when implementing EMR and CPOE in pediatric hospitals [18].

Edward's thesis introduced a user-centered implementation (UCI) framework that combines tools and methods from UCD and change management and links them to the systems implementation lifecycle. The UCI framework aims to provide implementation teams with guidance on which UCD and change management methods and tools can be applied at each stage of the system lifecycle. The ultimate goal of introducing the framework in a healthcare organization is to encourage greater use and acceptance of EMR and CPOE systems among clinicians.

Despite the similarity between the UCI framework and the UCCM process in combining the UCD and change management approaches to enhance users' acceptance of the CPOE system, they are, in fact, different.

- The UCI framework describes how to put the UCD and change management approaches into practice when implementing EMR and CPOE systems in pediatric hospitals. It maps each stage of the systems implementation lifecycle with the possible methods and tools of the two approaches that can be used in that stage. However, the UCCM process is about creating a change management plan that is user-centered. The UCCM process provides guidance on how to manage the CPOE accompanying change using a user-oriented change management plan.
- The UCI framework identifies the UCD methods to address the EHR and CPOE usability within the clinical work context. It also identifies the change management methods to address the organizational change needs associated with the EHR and CPOE implementation. Then, link those methods to different stages of the system lifecycle. On the other hand, the UCCM process uses the UCD approach, methods, and tools to plan for the change associated with the CPOE implementation.
- Moreover, the UCCM process focus is on developing and implementing the CPOE change management plan. In the UCCM process, the change management plan is considered as a system. Hence, the UCD approach is used to design, evaluate, and execute that system.
- The UCI framework was developed to fill the gap between users and IT, while the UCCM process was created to fill the gap between users and the change management planning process.

Even though the UCI framework and the UCCM process share similar change success factors and the same ultimate goal (users' acceptance of the system), the UCCM process provides many advantages over the UCI framework:

- The UCCM process uses a well-known change management model (Kotter's model) that has been tested and used in different settings as its base. The goal

is to make change management planning easier for managers and decision-makers.

- The UCCM process provides a comprehensive change management plan with clear steps and explanations.
- The UCCM process is straightforward and easy to follow because it provides clear input, goals, expected outputs and actors of each of the steps. It also clarifies how users are involved in each step. Therefore, managers and other decision-makers with less knowledge and experience in change management can simply follow the UCCM process to have a clear road map.
- The UCCM process focuses on the change process more than the used tools and methods.
- The UCCM process employs previous experience of the same organization that implements CPOE or of peer organizations to learn and avoid repeating the same mistakes.
- The UCCM process was built based on factors that affect users' acceptance of the CPOE system. Managers and other decision-makers can apply tools that suit the situation as long as they understand each step's goal.
- The UCCM process was developed and improved with healthcare informants who have witnessed users' resistance firsthand and who are working on CPOE implementation.
- The UCCM process allows users to be involved in the change management plan design and evaluation directly and indirectly.
- The UCCM process divides the change management plan into nine sub-plans to achieve a holistic design.
- The UCCM process provides a comprehensive evaluation plan that monitors and evaluates the change process as well as the implemented system.
- The UCCM process provides a post-implementation survey that measures the users' satisfaction with the used change process to improve the current change management plan or plan for future similar projects.

- The UCCM process provides a new approach to change management. It incorporates change management and UCD approaches to introduce an iterative development of a change management plan that is user-led.

Because knowledge is built in layers, both the UCI framework and the UCCM process can benefit from each other:

- The UCCM process can be used as part of the UCI framework to facilitate change management planning.
- The UCCM process can benefit from the UCI framework in considering what tools and methods can be used to improve the CPOE system's usability.

In works related to the use of change management in CPOE implementation (from Section 3.3), the work of Upperman et al. [20] is the closest to the UCCM process. Their paper reported on the implementation of the CPOE system of the Children's Hospital of Pittsburgh (CHP). Specifically, it documented the CHP's successful experience in implementing the CPOE system using an organizational change management strategy.

The paper provides a useful list of lessons learned and things to avoid when implementing a CPOE system. This list is however very general and does not explain how to operationalize these lessons and advice.

The main difference between the UCCM process and the work of Upperman et al. [20] is that they have documented the CHP's successful implementation strategy of the CPOE system, while my work is about providing a comprehensive change management plan that is inspired by the UCD approach. Moreover, the UCCM process development was driven by the general needs of clinicians. Those needs were identified first in collaboration with key healthcare informants and also were identified from current literature. Hence, the UCCM process is a general change management plan that can be applied by different healthcare organizations and not limited to one location.

Another important part of this thesis is reviewing the factors that affect users' acceptance of the CPOE system (Section 3.2). The review I have done is not the only review that considers healthcare professionals' acceptance factors. Many previous reviews have considered such factors for HIT in general [4], [176]–[179]. However, my review, in addition to being more recent, is contributing differently to the body of knowledge in that:

1. It focuses exclusively on CPOE systems.
2. It considers the implementation strategy as a separate and important part of the implementation.
3. It considers an existing, representative change management model and its relation to the factors.
4. It focuses on clinicians as they are the primary users of the system.
5. It provides more detailed categories for the factors derivative from the categories commonly considered (technological, people, and organizational).

7.4. Challenges and Limitations

In this section, I discuss the challenges that affect the conduction of this research. I also present the important limitations associated with this research.

7.4.1 Challenges

The major challenges I faced during this research were related to the evaluation of the UCCM process in a real environment. This research has started as a collaboration with a Canadian hospital (Hospital A), where I was supposed to collect data in collaboration with researchers and project managers, and then evaluate my new process. Unfortunately, despite spending much time developing questionnaires in both English and French and updating the study on several occasions at the request of the hospital's and the university's research ethics boards (REB), the hospital's project was postponed several times, and will likely not be implemented before the end of the pandemic.

Due to those unforeseen changes and delays in the CPOE project, I decided to update the evaluation to include the experience of another hospital (Hospital B) that has implemented a CPOE system a few years ago. Unfortunately, that hospital was not responsive, and our main contact retired during the summer. Additionally, I could not locate any useful documents about that hospital's experience with its CPOE implementation.

When the COVID-19 pandemic started, both hospitals went into crisis management mode, making it extremely difficult to do any research or get any response. Due to those unfortunate changes and delays in the CPOE project at Hospital A, the lack of

appropriate documents about Hospital B's experience, and finally COVID-19, I decided to use a retrospective case study to evaluate the proposed approach.

The other challenge I faced was the scarcity of reports on CPOE projects failures. Researchers, in general, prefer to report on successful projects and lessons learned from such projects. That makes it challenging to identify the reasons for failure and how the proposed research could help to avoid those reasons. Additionally, there is a drought in the studies that consider the actual CPOE implementation process because those studies require access to the healthcare organizations and the following of implementation over a more extended period [180]. The only report of value from the past 15 years was the one used in the previous chapter (IHealth).

7.4.2 Limitations

Despite its role in facilitating the implementation of the CPOE system and enhancing users' acceptance of the system, the UCCM process has some limitations:

- The UCCM process was developed on the assumption that the CPOE system has already been designed and is ready to be configured and implemented. In my argument, commercial systems are used broadly, and managers at this stage of the project may not have much control over the system design itself. Hence, the focus here is on how to develop a flexible and customizable change management plan.
- The development of the change management plan using the UCCM process can be costly and time consuming. However, organizations can either invest in proper change management from the beginning or spend their resources managing resistance later. In most cases, the former option is cheaper than the latter.
- Decision-makers may argue that they do not have the time to address issues such as users' feelings and perspectives towards the new system. Such activities would undoubtedly contribute to supporting and enhancing the success of the change process and users' acceptance of the system.
- Involving users in each step has some side effects. By sharing their needs and requirements, users may expect them all to be satisfied. In the real world, organizations cannot satisfy every single user. The idea is to meet most of the needs within the available budget and resources. To avoid users' frustration, decision-makers

must be clear from the beginning about the possibility of not meeting all user requirements.

- The UCCM process does not scale down to small organizations, so small clinics such as one-physician clinics may not benefit from the UCCM process.
- The UCCM process presented the change as a linear process. It is important to clarify that change does not proceed linearly. However, I chose to present it in this way to make it easier for the readers and decision-makers to understand the activities, even if iterations (also supported by the UCCM process) are expected in practice.

7.5. Threats to Validity

As explained by Runeson et al., "The validity of a study denotes the trustworthiness of the results, and to what extent the results are not biased by the researchers' subjective point of view" [181]. This section addresses some potential threats to the research validity and the extent to which they were mitigated. In the following subsection, I considered three aspects of validity: construct validity, internal validity, and external validity.

7.5.1 Construct Validity

Construct validity measures the degree to which the used case studies or other evaluation tools are able to answer the research questions. This thesis's major threat to construct validity is the lack of a case study where the UCCM process is evaluated in a real environment. To mitigate this threat, as explained in the previous section, I opted for a retrospective case study to evaluate the UCCM process's ability to solve common challenges faced by healthcare organizations when implementing their CPOE system.

The second threat is that the selected retrospective case study did not include some of the required details that show the complexity of the CPOE implementation project. The third threat in this thesis is that the usefulness and usability of the UCCM process were not assessed in practice by real users, such as managers and clinicians.

To mitigate those threats, I first demonstrated and validated the UCCM process with healthcare informants. Then, I validated the process against existing healthcare change management guidelines/frameworks. Additionally, the two surveys that are part of the

UCCM process were created and validated with healthcare informants who worked on a real CPOE implementation. Both surveys were also approved by the Research Ethics Boards of Hospital A and the University of Ottawa. Moreover, the "User Requirements Survey" was deployed as a pilot in Hospital A. Appendix D presents the survey's results.

Finally, the literature review on key factors that contribute to clinicians' acceptance of CPOE systems was submitted for publication to validate its results with experts in the field.

7.5.2 Internal Validity

Internal validity reflects the degree to which a resulting conclusion is justified as well as the selection bias and confounding factors. The major threat in this category is the assumption that users' involvement in change management planning is the main factor that contributes to the resistance of the change. A systematic literature review was performed to examine the factors that affect users' acceptance of the CPOE system and their relation to change management to mitigate this threat.

The other threat is the possible bias that resulted from the fact that I have selected the case study and analyze it by myself. The same type of potential bias applies to the three-part literature review I did in Chapter 3. However, this was mitigated partly by involving my supervisor in reviewing the work, and by publishing the results.

7.5.3 External Validity

External validity reflects the degree to which the research result can be generalized confidently to other domains or contexts under different settings. In this thesis, the external validity reflects the extent to which the UCCM process can be generalized to other hospitals, and other HIT. The major threat in this research is that only one retrospective case study was used. Mitigating this threat requires using multiple case studies that consider different organizations with different settings.

Nevertheless, the UCCM process was developed based on existing approaches whose effectiveness in practice has been demonstrated in many industries and systems. This increases the UCCM process's applicability to other hospitals implementing a CPOE system (and possibly, with adaptations, to other types of HIT systems).

7.6. Chapter Summary

This chapter discusses the significance of the study in the fields of change management and HIT. The thesis has several positive impacts on the CPOE system, managers, clinicians, and patients. The significant result is that the CPOE system will more likely be appropriately utilized and accepted by the users than without using the UCCM process.

Although the idea of combining UCD and change management for CPOE systems implementation has been considered before in one framework, the UCCM process combines those approaches for a different reason, mainly to develop a user-driven change management plan. Two key points that distinguishes the UCCM process from other work are: 1) the UCCM process fills the gap in CPOE implementation by presenting a comprehensive change management plan that is inspired by the UCD approach and allows users to be involved in the change management plan design and evaluation directly and indirectly, and 2) the UCCM process was built based on factors that affect users' acceptance and the experience and knowledge of healthcare informants who are working on the CPOE implementation.

Despite the challenges and limitations of the UCCM process, it still provides an excellent opportunity for decision-makers to involve users and get their approval of the change.

In the next chapter, I conclude this thesis with a summary of its contributions and answers to the research questions. I also identify potential future work.

Chapter 8. Conclusions and Future Work

This chapter summarizes the contributions of this thesis and answers the research questions. It also explores future directions of this research.

8.1. Thesis Contributions

The involvement of users in the implementation of a CPOE system improves the chances of seeing their interests and requirements being well catered for. Such involvement will affect users' acceptance and use of the system as well as their longer-term engagement. However, there is a lack of guidance on how to involve clinicians in the implementation of CPOE systems, specifically in planning for change management. This thesis partially addresses this problem through the introduction of its **major contribution** (prescriptive knowledge), namely the *UCCM process*, which provides guidance on planning and managing the change accompanying the CPOE system's implementation. The UCCM process defined in Chapter 4:

- Offers a process that combines UCD and change management approaches.
- Provides a customizable guide that can be adjusted to meet the needs of different users, organizations, and clinical settings.
- Defines a systematic change process that makes users the center of the change.
- Explains to decision-makers how to engage users in every step.
- Specifies actors for each step.
- Provides clear goals, input, and output for each step.
- Suggests tools and methods to execute the process steps.
- Utilizes the organizations' previous experiences and the experiences of peer organizations as well.
- Gives decision-makers the opportunity to plan ahead. For instance, planning on how to use the same survey to collect necessary data for multiple steps at once.

- Develops effective communication and training programs that meet the clinicians' needs and requirements.
- Utilizes a multidisciplinary change committee to engage different perspectives in each process.
- Provides an iterative mechanism to incorporate feedback and improve the developed change management plan.
- Provides two-way communication between the decision-makers and the potential users to develop an accurate understanding of users' needs, requirements, priorities, concerns, expectations, and the implementation process and timeline.
- Provides survey examples, which have been reviewed by key healthcare informants and approved by the REBs of Hospital A and the University of Ottawa, that can help:
    - Collect user requirements to improve their acceptance of the CPOE system. The survey is available in English and French (Appendix A). It was deployed as a pilot in Hospital A. Appendix D presents the survey's results.
    - Measure users' satisfaction of the change management plan after the CPOE implementation (Appendix B).

UCCM represents particularly novel knowledge as the first user-centered change management process, even outside of healthcare.

One **minor contribution** of the thesis, which provides descriptive knowledge, is a systematic literature review on the factors that can affect users' acceptance of CPOE systems.

8.2. Answers to Research Questions

The thesis contributions help answer the three research questions raised in Section 1.6, as follows:

RQ1: *What are the key activities/factors that influence clinical users' acceptance of the CPOE systems?*

Answer: The literature review in Chapter 3 (and especially Section 3.2) investigated the factors that influence clinicians' acceptance of CPOE systems. The review has identified two types of factors: one related to the used implementation strategy and the other related to the CPOE system design. The factors are classified into six areas: resources, workflow, users' perception, users' engagement/involvement, training and support, and usability. The first five areas are related to the implementation strategy, and the sixth area is related to the CPOE system design process. Table 7 summarizes the CPOE factors (barriers and recommendations) that affect users' acceptance.

RQ2: *What is the relationship between the acceptance factors and existing change management strategies?*

Answer: To answer this question, I conducted another literature review on the change management role in enhancing users' acceptance of the CPOE system (Section 3.3). The result of this review showed that most of the change management principles are considered during the implementation of the CPOE system to prepare users and organizations for the change. Table 8 summarizes the change management principles in CPOE. Additionally, I compared Kotter's model with the retrieved recommendations from Table 7. I found many similarities and much overlapping. Section 3.3.3 explained every phase of Kotter's model and how it is linked to the acceptance factors. The result of this comparison is presented in Table 9 to show the links between CPOE acceptance factors and Kotter's model.

RQ3: *To what extent does the integration of UCD principles with change management improve clinical users' acceptance of the CPOE systems?*

Answer: The retrospective case study I presented in Chapter 6 showed that integrating the UCD and change management in the form of the UCCM process could help a CPOE project team develop a more effective change management plan to reduce resistance and increase acceptance and satisfaction. Moreover, the UCCM process would have saved the IHealth system from facing many of the issues that caused users resistance to the system, and would have indirectly prevented some financial loss.

8.3. Future Work

To improve the effectiveness and usefulness of the UCCM process, the following items would be interesting and important to perform in the future:

- Continue the work with Hospital A to apply the UCCM process when the CPOE implementation is resumed. I already started distributing the user requirements survey to the hospitals' employees before the project postpended.
- Apply the UCCM process in different hospitals and settings to investigate the process usability in other conditions. That also includes different contexts (teaching/non-teaching hospitals, size, rural/urban) and types of systems (standalone and integrated with EHRs).
- Apply the UCCM process to a different healthcare system. The UCCM process was developed based on the Canadian and American healthcare systems. It would be interesting to adopt the UCCM process to a different healthcare system, particularly the Saudi healthcare system.
- Evaluate the UCCM process's usability with the managers and decision-makers who are responsible for developing the change management in the CPOE project.
- Develop an activity list that accompanies each step of the UCCM process to elaborate on what it takes to execute that step. Alongside the activities, the list should suggest appropriate methods, tools, and techniques.
- Develop an online support platform (Web-based repository of resources) that contains the different methods, tools, and techniques that can be used in each step of the UCCM process. The goal is to assist the decision-makers, especially those who are less experienced with change management.
- Develop indicators to measure progress and performance for each step to evaluate each step's effectiveness in achieving the intended result.
- Combine existing work on the CPOE usability issues to complement the UCCM process, for instance by looking at ways to combine the UCD-oriented steps of UCCM and those needed for the customization of CPOE configurations and ordered sets.

- Generalize the UCCM process to other HIT systems other than CPOE, or even to domains other than healthcare.

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Appendix A: User Requirements Survey

This appendix presents the structure and content of the User Requirements Survey, in both English and French.

A.1 English Survey

User Requirements Survey

Introduction:

The aim of this survey is to explore clinicians' requirements and preferences during Computerized Provider Order Entry (CPOE) system implementation.

Participating in this study will help us to highlight different requirements and unseen issues associated with some aspects of CPOE implementation. The result of this survey will help us increasing the clinicians' acceptance of the system by creating suitable CPOE communication and training plans.

The survey contains 34 questions distributed over four sections: demographic information, self-reported computing and CPOE experience, preferences and requirements, and expectations and engagement.

NOTE: Please be advised that not all requests can be accommodated. The result of the survey will be used as a reference to improve the CPOE implementation process. No changes will be made to the CPOE system itself.

Section 1: *demographic information.*

1. What is your age group? (in years)
   - 18-29
   - 30-39
   - 40-49
   - 50-59
   - 60 and over

2. What is your current job position?
   - Physician/Resident
   - Nurse practitioner
   - Nurse
   - Pharmacist
   - Other (please specify) ……...

3. If a physician, what is your position as the date of survey:
   - Attending
   - Fellow
   - Resident 1st year
   - Resident 2nd year
   - Resident 3rd year
   - Resident 4th year
   - Resident 5th year
   - Medical Student
   - Other (please specify) ……...

4. If a physician, please specify specialty:
   - Family Practice
   - Adult/Internal medicine
   - Mental/Behavioural Health
   - Midwife
   - OB/GYN/Women's Health
   - Pediatrics
   - Emergency specialties
   - Surgical specialties
   - Other (please specify)

5. What is your main setting? (Check only one)
   - Inpatient unit/ward: medical/ surgical
   - Inpatient unit/ward: critical care
   - Outpatient ambulatory clinic or specialist clinic
   - Emergency Department
   - Obstetrics
   - Laboratory, radiology or other diagnostic unit
   - Other (Please specify): _____

6. How many years of experience do you have as a practitioner?
   - Less than 5
   - 5-10
   - 11-15
   - 16-20
   - 21-25
   - More than 25

7. How many hours do you work per week on average?
   ……

Section 2: *Self-reported computing and CPOE experience.*

8. How would you rate your computer proficiency?
   - None
   - Basic
   - Average
   - Advanced
   - Expert

9. Do you think a CPOE system is different from an Electronic Medical Record (EMR) or a clinic prescription system?
   - Yes
   - No
   - I don't know

What is a CPOE? A Computerized Provider (or Physician/Prescriber/Practitioner) Order Entry system is a software application used by clinicians to digitally enter diagnostic and therapeutic orders and then electronically transmit those orders to the appropriate departments or services for execution. CPOE is usually incorporated with a *Clinical Decision Support System* (CDSS) to support clinicians and improve quality and safety by reducing errors at various stages during the order-entry process. The offered support usually includes, but is not limited to, checking for required fields, offering a list of default orders or order sets, and dosing calculation taking into account patient characteristics, recent test results, and knowledge-based rules.

10. Have you used a CPOE system before?
    - Yes
    - No

11. If yes, what CPOE system did you use?
    - Hospital
    - Office

    Which system? (Please specify) …….

12. If yes, how long have you used/been using CPOE?
    - Less than a month
    - 1-3 months
    - 4-6 months
    - 7-12 months
    - 1-2 years
    - 3-5 years
    - Over 5 years

13. If yes, what training with CPOE did you have? (Check all that apply)
    - Formal training
    - Workshops or conferences
    - Self-guided learning
    - None
    - Other (Please specify): _____

14. If yes, from your previous experience with CPOE, how would you rate the following:

	Excellent	**Good**	**Average**	**Poor**	**Very poor**
A. Your experience with the CPOE system, in general.					
B. Your ability to use the CPOE system.					
C. The implementation process of CPOE.					
D. The consultation with users during CPOE implementation					
E. The quality of the services (i.e., technical support and training services) provided for CPOE.					
F. The level of training you had					
G. The level of ongoing support provided					
H. The level of CPOE team help.					
I. The amount and quality of communication you received before CPOE implementation.					
J. The overall support for CPOE go-live					

15. If yes, from your previous experience with CPOE, please indicate the level of agreement or disagreement with each of the following:

	Strongly Agree	**Moderately Agree**	**Moderately Disagree**	**Strongly Disagree**	**Not Sure**	**Not Applicable**
A. I prefer using CPOE to traditional paper-based system						
B. Because of training received, I am more apt to use CPOE.						
C. Because of communication used, I am more apt to use CPOE.						
D. Because of my involvement in the implementation process, I am more apt to use CPOE.						
E. My fears were addressed before CPOE implementation.						
F. I was well prepared to use CPOE						
G. I knew how to get help or who to ask if I have questions about CPOE						

16. If yes, what did you find the most difficult to learn? Why?

……
……
……
……

17. In order to plan for a refresher and pretraining before the CPOE training, please rate your ability to perform the following tasks:

	Confident	**Need Refresher**	**Not Sure**	**Not Applicable**
Documenting patient information (e.g., history and physicals, progress notes)				
Accessing clinical data (e.g., laboratory data, EKGs, radiology reports)				
Communicating with healthcare team				
Obtaining advice on specific patient's diagnosis or therapy				

18. How would you rate your frequency of using the new CPOE system? Why?
    - o Frequent
    - o Infrequent

    Please specify why.

……
……
……
……

19. During you working hours, how many times do use/expect to use the CPOE system?

……..
……..
……..
……..

Section 3: *Preferences and requirements.*

20. Which language do you prefer for training and communication?
    - o English
    - o French

21. In your opinion, how close should the training happen before the deployment (go-live)? (In months)

    ……

22. For CPOE training, I prefer (select all that apply):
    - o One on one coaching
    - o Online training
    - o Small group training
    - o Other (please specify) ……...

23. I prefer to have training during
    - o Weekday early morning
    - o Weekday during the day
    - o Lunch hour
    - o Weekday evening
    - o Weekend

24. In your opinion, what is the ideal training duration of each session
    - o Less than an hour
    - o One hour
    - o Two hours
    - o Three hours
    - o Other (please specify) …….

25. Can you think of any special needs that should be accommodated with during training sessions? (if yes, please specify)
    ……
    ……
    ……
    ……
    ……
    ……

26. Would you like to have access to a test version prior to deployment?
    - o Yes
    - o No

27. What communication channels do you prefer using to receive more information about the CPOE system?
    - o Email
    - o Regular meetings
    - o Newsletters
    - o Department meetings
    - o Text messages (SMS)
    - o Other (please specify) …….

28. If you need help for using the CPOE system, which sources would you prefer using?
    - o IT support
    - o Colleagues
    - o Tutorials
    - o Online videos
    - o User documentation
    - o Help section
    - o Search Online
    - o Other (please specify) …….

Section 4: *Expectations and engagement.*

29. What could hinder your acceptance of the CPOE system?
    ……
    ……
    ……
    ……
    ……
    ……

30. What could facilitate your acceptance of the CPOE system?
    ……
    ……
    ……
    ……
    ……
    ……

31. What do you fear about the implementation of CPOE? (select all that apply)
    - o Time consuming in comparison to existing system
    - o Increase workload
    - o Jeopardize patient safety
    - o Interrupt interaction with patients
    - o Reduce number of patients seen
    - o Decline in salary
    - o Perceived individual benefits
    - o Inadequate training
    - o Lack of knowledge/confidence
    - o Loss of data
    - o Losing access to data when needed
    - o Other (please specify) …….

32. Would additional involvement in CPOE implementation plan increase your acceptance level of the system?
    - o Yes
    - o No

    Please specify why.

……
……
……
……
……

33. How would you rate the following statements?

	Excellent	**Good**	**Average**	**Poor**	**Very poor**
A. Your motivation to pick up new skills to use a CPOE system effectively					
B. Your opinion about the CPOE system's expected benefits to your organization					
C. Your opinion about the CPOE system's expected benefits to you					
D. Your current acceptance of the new CPOE system					
E. Your feeling about having answered this survey as a means of getting involved in the CPOE implementation plan					

34. Do you have any other comments, suggestions, or concerns?

    ……
    ……
    ……
    ……
    ……

A.2 French Survey

Sondage sur les exigences des utilisateurs du système CPOE

Introduction

Le but de cette enquête est d'explorer les exigences et les préférences des cliniciens lors de la mise en œuvre du système de saisie informatisée des commandes (CPOE).

La participation à cette étude nous aidera à mettre en évidence différentes exigences et problèmes invisibles associés à certains aspects de la mise en œuvre du CPOE. Le résultat de cette enquête nous aidera à accroître l'acceptation du système par les cliniciens en créant des plans de communication et de formation appropriés pour le CPOE.

L'enquête comprend 34 questions réparties sur quatre sections: informations démographiques, informatique autodéclarée et expérience CPOE, préférences et exigences, et attentes et engagement.

NOTEZ BIEN: veuillez noter que les demandes faites ici pourraient ne pas être satisfaites. Le résultat de l'étude sera utilisé comme référence pour améliorer le processus de mise en œuvre du CPOE. Aucune modification ne sera apportée au système CPOE lui-même.

Section 1: *Informations démographiques.*

1. Quel est votre groupe d'âge (en années)?
   - 18-29
   - 30-39
   - 40-49
   - 50-59
   - 60 et plus

2. Quel est votre poste actuel?
   - Médecin / résident
   - Infirmière praticienne / Infirmier praticien
   - Infirmière / Infirmier
   - Pharmacien(ne)
   - Autre (veuillez préciser) ……...

3. Si vous êtes médecin, quelle est votre position à la date du sondage:
   - o Médecin traitant
   - o Fellow / chercheur(e)
   - o Résident(e) de 1ère année
   - o Résident(e) de 2e année
   - o Résident(e) de 3e année
   - o Résident(e) de 4e année
   - o Résident(e) de 5e année
   - o Étudiant(e) en médecine
   - o Autre (veuillez préciser) ……...

4. Si vous êtes médecin, veuillez préciser la spécialité:
   - o Médecine familiale
   - o Médecine adulte / interne
   - o Santé mentale / comportementale
   - o Sage-femme
   - o Obstétrique / Gynécologie / Santé des femmes
   - o Pédiatrie
   - o Spécialités d'urgence
   - o Spécialités chirurgicales
   - o Autre (veuillez préciser) ……...

5. Quel est votre environnement principal? (Cochez une seule case)
   - o Unité / salle d'hospitalisation: médicale / chirurgicale
   - o Unité / salle d'hospitalisation: soins intensifs
   - o Clinique ambulatoire (consultation externe) ou clinique spécialisée
   - o Service d'urgence
   - o Obstétrique
   - o Laboratoire, radiologie ou autre unité de diagnostic
   - o Autre (veuillez préciser): ……...

6. Combien d'années d'expérience avez-vous en tant que praticien(ne)?
   - o Moins de 5
   - o 5-10
   - o 11-15
   - o 16-20
   - o 21-25
   - o Plus de 25

7. Combien d'heures travaillez-vous en moyenne par semaine?
   ……

Section 2: *Expérience en informatique autodéclarée et en CPOE.*

8. Comment évalueriez-vous votre niveau de compétence en informatique?
   - Aucun
   - De base
   - Moyen
   - Avancé
   - Expert

Qu'est-ce qu'un système CPOE – Computerized Provider (or Physician / Prescriber / Practitioner) Order Entry? Un système informatisé d'entrée d'ordonnances par un médecin / prescripteur / praticien est une application logicielle utilisée par les clinicien(ne)s pour saisir numériquement les ordonnances diagnostiques et thérapeutiques, et pour transmettre électroniquement ces ordonnances aux unités ou services appropriés pour exécution. Le CPOE est généralement intégré à un système d'aide à la décision clinique (CDSS) pour aider les clinicien(ne)s et améliorer la qualité et la sécurité en réduisant le nombre d'erreurs à différentes étapes du processus de saisie des ordonnances. L'assistance proposée comprend généralement, entre autres, la vérification des champs obligatoires, une liste d'ordonnances ou d'ensembles d'ordonnances par défaut, de même que le calcul du dosage en tenant compte des caractéristiques des patients, des résultats de tests récents et de règles basées sur les connaissances.

9. Pensez-vous qu'un système CPOE est différent d'un dossier médical électronique (*Electronic Medical Record* – EMR) ou d'un système de prescription en clinique?
   - Oui
   - Non
   - Je ne sais pas

10. Avez-vous déjà utilisé un système CPOE?
    - Oui
    - Non

11. Si oui, quel type de système CPOE avez-vous utilisé?
    - Hôpital
    - Clinique/bureau

    Quel système? (Veuillez spécifier) …….

12. Si oui, depuis combien de temps utilisez-vous (ou combien de temps avez-vous utilisé) un système CPOE?
    - o Moins d'un mois
    - o 1-3 mois
    - o 4-6 mois
    - o 7-12 mois
    - o 1-2 années
    - o 3-5 années
    - o Plus de 5 années

13. Si oui, quelle formation avez-vous reçue pour le système CPOE? (Cochez toutes les cases applicables)
    - o Formation formelle
    - o Ateliers ou conférences
    - o Apprentissage autoguidé
    - o Aucune
    - o Autre (veuillez préciser): ……

14. Si oui, selon votre expérience précédente avec les systèmes CPOE, comment évalueriez-vous ce qui suit:

	Excellent	**Bon**	**Moyen**	**Faible**	**Très faible**
A. Votre expérience avec le système CPOE, en général.					
B. Votre capacité à utiliser le système CPOE.					
C. Le processus d'implantation du système CPOE.					
D. La consultation des utilisateurs lors de l'implantation du système CPOE.					
E. La qualité des services (c'est-à-dire les services de support technique et de formation) fournis pour le système CPOE.					
F. Le niveau de formation que vous avez suivi.					
G. Le niveau de soutien continu fourni.					
H. Le niveau de l'équipe d'aide CPOE.					
I. La quantité et la qualité de l'information que vous avez reçue avant l'implantation du système CPOE.					
J. Le soutien global à la mise en service du système CPOE.					

15. Si oui, selon votre expérience précédente avec les systèmes CPOE, comment évalueriez-vous ce qui suit:

	Fortement d' accord	**Modérément d' accord**	**Modérément en désaccord**	**Fortement en désaccord**	**Incertain**	**Sans objet**
A. Je préfère utiliser le système CPOE au système papier traditionnel						
B. Grâce à la formation reçue, je suis plus apte à utiliser le système CPOE.						
C. Grâce à la communication utilisée, je suis plus apte à utiliser le système CPOE.						
D. Grâce à mon implication dans le processus d'implantation, je suis plus apte à utiliser le système CPOE.						
E. Mes craintes ont été prises en compte avant l'implantation du système CPOE.						
F. J'étais bien préparé(e) à utiliser le système CPOE.						
G. Je savais comment obtenir de l'aide ou à qui demander si j'avais des questions sur le système CPOE.						

16. Si oui, qu'avez-vous trouvé le plus difficile à apprendre? Pourquoi?

……
……
……
……

17. Afin de planifier un cours de recyclage et une formation préalable avant la formation au système CPOE, veuillez évaluer votre capacité à effectuer les tâches suivantes:

	Confiant	**Besoin de recyclage**	**Incertain**	**Sans objet**
Documenter les informations sur les patients (par exemple, les antécédents et aspects physiques, et les notes de progression).				
Accès aux données cliniques (par exemple, données de laboratoire, électrocardiogrammes, rapports de radiologie).				
Communiquer avec l'équipe soignante.				
Obtenir des conseils sur le diagnostic ou la thérapie d'un patient spécifique.				

18. Comment évalueriez-vous votre fréquence d'utilisation future du nouveau système CPOE? Pourquoi?
    - o Fréquente
    - o Peu fréquente

    Veuillez indiquer pourquoi.

……
……
……
……

19. Pendant vos heures de travail, combien de fois comptez-vous utiliser le système CPOE?

……
……
……
……

Section 3: *Préférences et exigences.*

20. Quelle langue préférez-vous utiliser pour la formation et la communication?
    - o Anglais
    - o Français

21. À votre avis, à quelle moment (en mois) la formation devrait-elle avoir lieu *avant* le déploiement (mise en service)?
    ……

22. Pour la formation du système CPOE, je préfère (sélectionnez tout ce qui s'applique):
    - o Coaching individuel
    - o Formation en ligne
    - o Formation en petits groupes
    - o Autre (veuillez préciser) ……...

23. Je préfère suivre une formation:
    - o En semaine tôt le matin
    - o En semaine pendant la journée
    - o Pendant l'heure du dîner
    - o En semaine le soir
    - o La fin de semaine

24. Selon vous, quelle est la durée idéale de chaque session de formation?
    - o Moins d'une heure
    - o Une heure
    - o Deux heures
    - o Trois heures
    - o Autre (veuillez préciser) …….

25. Pouvez-vous penser à des besoins spéciaux qui devraient être satisfaits pendant les sessions de formation? (Si oui, veuillez spécifier)
    ……
    ……
    ……
    ……
    ……

26. Souhaiteriez-vous avoir accès à une version de test avant le déploiement?
    - o Oui
    - o Non

27. Quels moyens de communication préférez-vous utiliser pour recevoir plus d'informations sur le système CPOE?
    - o Courriel
    - o Réunions régulières
    - o Bulletins
    - o Réunions du département / de l'unité
    - o Messages texte (SMS)
    - o Autre (veuillez préciser) …….

28. Si vous avez besoin d'aide pour utiliser le système CPOE, quelles sources préféreriez-vous utiliser?
    - o Support informatique
    - o Collègues
    - o Tutoriels
    - o Vidéos en ligne
    - o Documentation utilisateur
    - o Section d'aide
    - o Recherche en ligne
    - o Autre (veuillez préciser) …….

Section 4: *Attentes et engagement.*

29. Qu'est-ce qui pourrait entraver votre acceptation du système CPOE?
    ……
    ……
    ……
    ……
    ……
    ……

30. Qu'est-ce qui pourrait faciliter votre acceptation du système CPOE?
    ……
    ……
    ……
    ……
    ……
    ……

31. Que craignez-vous de l'implantation du système CPOE? (Sélectionnez tout ce qui s'applique)
    - o Plus exigeant en temps par rapport au système existant
    - o Augmentation de la charge de travail
    - o Sécurité des patients mise en péril
    - o Interruption de l'interaction avec les patients
    - o Réduction du nombre de patients vus
    - o Baisse de salaire
    - o Bénéfices individuels perçus
    - o Formation inadéquate
    - o Manque de connaissances / confiance
    - o Perte de données
    - o Perte de l'accès aux données en cas de besoin
    - o Autre (veuillez préciser) …….

32. Une participation plus grande au plan d'implantation du système CPOE augmenterait-elle votre niveau d'acceptation du système?
    - o Oui
    - o Non

    Veuillez spécifier pourquoi.

……
……
……
……
……

33. Comment évalueriez-vous ce qui suit?

	Excellent	**Bon**	**Moyen**	**Faible**	**Très faible**
A. Votre motivation à acquérir de nouvelles compétences pour utiliser efficacement un système CPOE.					
B. Votre opinion sur les avantages escomptés du système CPOE pour votre organisation.					
C. Votre opinion sur les avantages escomptés du système CPOE pour vous.					
D. Votre acceptation actuelle du nouveau système CPOE.					
E. Votre sentiment face à ce sondage comme moyen de vous impliquer dans le plan d'implantation du CPOE.					

34. Avez-vous d'autres commentaires, suggestions ou inquiétudes?

……
……
……
……
……

Appendix B: User Satisfaction Survey

User Satisfaction Survey

Introduction:

The aim of this survey is to answer the question "To what extent did the used change plan improve clinical users' acceptance of the CPOE system?".

Participating in this survey will help us to measure the level of clinicians' satisfaction with the CPOE training/communication and perception about being involved in the plan design process.

The survey contains 18 questions distributed over three sections: demographic information, self-reported computing and CPOE experience, and users' level of satisfaction with CPOE implementation process.

Section 1: *Demographic Information*

1. What is your age group? (in years)
   - 18-29
   - 30-39
   - 40-49
   - 50-59
   - 60 and over

2. What is your current job position?
   - Physician/Resident
   - Nurse practitioner
   - Nurse
   - Pharmacist
   - Other (please specify) ……...

3. If a physician, what is your position as the date of survey:
   - Attending
   - Fellow
   - Resident 1st year
   - Resident 2nd year
   - Resident 3rd year
   - Resident 4th year
   - Resident 5th year
   - Medical Student
   - Other (please specify) ……...

4. If a physician, please specify specialty:
   - Family Practice
   - Adult/Internal medicine
   - Mental/Behavioural Health
   - Midwife
   - OB/GYN/Women's Health
   - Pediatrics
   - Emergency specialties
   - Surgical specialties
   - Other (please specify)

5. What is your main setting? (Check only one)
   - Inpatient unit/ward: medical/ surgical
   - Inpatient unit/ward: critical care
   - Outpatient ambulatory clinic or specialist clinic
   - Emergency Department
   - Obstetrics
   - Laboratory, radiology or other diagnostic unit
   - Other (Please specify): _____

6. How many years of experience do you have as a practitioner?
   - Less than 5
   - 5-10
   - 11-15
   - 16-20
   - 21-25
   - More than 25

7. How many hours do you work per week on average?
   ……

Section 2: *Self-reported computing and CPOE experience*

8. How would you rate the following statements?

	Excellent	**Good**	**Average**	**Poor**	**Very poor**
A. Your computer skills in general					
B. Your experience with the new CPOE system					
C. Your ability to use the CPOE system					
D. Your current acceptance of the new CPOE system					
E. Your motivation to pick up new skills to use a CPOE system effectively					

9. What did you find the most difficult to learn?

……
……
……
……
……

10. How would you rate your frequency of using the CPOE system? Why?
    - o Frequent
    - o Infrequent

Please specify why.

……
……
……
……
……

11. During you working hours, how many times do use the CPOE system?

……
……

Section 3: *Users' level of satisfaction with CPOE implementation process.*

12. How would you rate the following statements?

	Excellent	**Good**	**Average**	**Poor**	**Very poor**
A. The training effect on your satisfaction with the CPOE system					
B. The training conducted before the launch of the system					
C. The quality and usefulness of the communication conducted before the launch of the system					
D. Your motivation to pick up new skills to use a CPOE system effectively					
E. Your engagement during the planning of the CPOE system					
F. Your overall satisfaction with the CPOE implementation plan					
G. Your overall satisfaction with the CPOE system					

13. Do you know what to do during CPOE down time?
    - Yes
    - No

14. Do you think your engagement has positively improved the CPOE implementation?
    - Yes
    - No

15. What do you think are positive points of your involvement?

    ……
    ……
    ……
    ……
    ……

16. What kind of improvement to the implementation process would you like to see?
    ……
    ……
    ……
    ……
    ……

17. Given the choice, would you go back to paper-based records?
    - Yes
    - No

18. What do you recommend for future change management projects based on lessons gained from this project?
    ……
    ……
    ……
    ……
    ……

.

Appendix C: Proposed IHealth Benefits, Outcome Indicators, and Process Metrics

As presented in the EY report on the review of Island Health's IHealth system [171].

Benefits (Objectives)	Outcome Indicators	Process Metrics
Clinical Quality & Safety		
Eliminate preventable *adverse drug events* (ADEs) and medication management related errors in acute and residential care	• Reduced # of ADEs per 1000 medication administrations • Reduced # of medication management related errors per 1000 medication orders	• Increased % of patients with medication history documented on admission • Increased % of patients with documented medication reconciliation on admission and discharge • Increased % of medication orders sent electronically • Increased % of patients with a documented medication adherence plan
Avoid *emergency department* (ED) visits and acute care admissions, e.g., during transitions from living at home to *Residential Care* (RC) placement	• Reduced % of home-to-RC transitions that involve an ED visit or acute care admission • Reduced % of clients who were identified by the MAPLe algorithm but not referred to RC and were subsequently admitted to acute care	• Increased % of at-home Home and Community Care clients who have a RC referral triggered when indicated by the Resident Assessment Instrument (RAI) MAPLe-algorithm based protocol

Benefits (Objectives)	Outcome Indicators	Process Metrics
Prevent *venous thromboembolism* (VTE) in acute care	• Reduced # of VTE incidents per 1000 VTE risk related admissions	• Increased % of at-risk inpatients who received appropriate VTE prophylaxis in keeping with clinical decision support (CDS) • Increased % of patients assessed for VTE risk within 24 hours of change in status
Prevent sepsis and its complications in acute care	• Reduced incidence of septic shock per 1000 admissions • Reduced % of target patients with mortality due to sepsis during hospital admission • Reduced average length of stay related to sepsis management	• Within target range for median time in minutes to administration of broad-spectrum antibiotics for severe sepsis or septic shock from the time of presentation • Increased % of target patients where sepsis protocol was fulfilled
Prevent *pressure ulcers* (PU) in acute care	• Reduced # of hospital acquired pressure ulcers per 1,000 patient days	• Increased % of patients assessed for risk within 24 • hours of admission, with prevention plan/order set initiated • Increased % of patients reassessed for PU risk daily or according to protocol
Prevent hospital-acquired infections and improve infection control	• Reduced # of patients with a hospital-acquired infection per 1000 discharges	• Increased % of patients assessed for *antibiotic resistant organisms* (ARO) risk within 24 hours of admission • Increased % of at-risk patients with precautions enacted per protocol • Reduced % of target surgical patients with appropriate antibiotics administered prior to surgery

Benefits (Objectives)	Outcome Indicators	Process Metrics
Patient-Driven Care		
Improve capacity for patient-driven care reflecting better information flow, customization, and patient choice and involvement	• Increased % of patients reporting satisfaction with the process and experience of planning & participating in care • Increased % of clients reporting care as being well-matched to their restorative or preventive care needs	• Increased % of clients with "Know-Me" view and care preferences / goals populated in the EHR • Increased % of encounters where care is consistent with "Know-Me" view • Increased % of patients entering self-tracking data into their EHR
Provider-Supportive Care		
Improve capacity to deliver standard- and protocol-aligned care associated with better health related outcomes	• Increased % of providers reporting satisfaction with the process and experience of planning & delivering care • Increased % of care venues where health authority 'best outcomes' are achieved	• Increased % of cases within a specified clinical cohort & timeframe where care adhered to the EHR clinical decision support (CDS) rules and protocols • Increased % of providers electronically tracking clinical activity against peer developed expectations of care quality and experience (patient, staff, and physician), informing team and individual practitioner quality and feeding into ongoing credentialing requirements
Health System Efficiency & Sustainability		
Decrease duplication and associated costs of diagnostic investigations	• Net annual costs associated with duplicate testing • Net total reduction in per patient exposure to radiation annually	• % of lab and radiology orders documented electronically versus verbally or handwritten • % of radiology orders assessed for appropriateness according to clinical decision support and peer ordering patterns using local data

Benefits (Objectives)	Outcome Indicators	Process Metrics
Improve timeliness of care due to more efficient data processing and access to better information	• Reduction in delays and costs due to incomplete or missing documentation • Reduced annual transcription and chart retrieval costs	• Reduced time spent documenting vital signs where device integration is in place • Reduced time from order to intervention with CPOE (computerized physician order entry) • Reduced turnaround times between orders placed and fulfilled (lab, imaging, pharmacy) • Reduced time for hospital discharge summary to arrive in physician's office
Optimize use of acute care resources	• Reduced overall average length of stay related to preventable causes of excess length of stay	• Increased use of clinical decision support functionality in the EHR to identify optimal care pathways and reduce incidence of preventable causes of excess length of stay (LOS)
Population Health		
• Reduce population risk for high incidence chronic disease, e.g., Type II Diabetes • Optimize clinical course and outcomes for populations with chronic conditions • Reduce morbidity associated with chronic conditions	• Increased % of monitored clients whose body mass index (BMI) is maintained within normal range – stratified by high-risk sub-populations, e.g., First Nations • Increased % of individuals with hypertension who have a blood pressure within target	• Increased % of community & acute encounters where height and weight are captured or updated electronically • Increased % of target patients with provider adherence to reminder-based protocol for periodic tracking of Hemoglobin A1c and fasting blood sugar (FBS) for diabetes monitoring • Increased % of individuals with heart failure who are on standard medical treatment protocols • Increased % of individuals with Chronic obstructive pulmonary disease (COPD) who have documented care plans

Benefits (Objectives)	Outcome Indicators	Process Metrics
Improve stable community placement of high need, high risk mental health and addictions clients	Per defined cohort, reduced: • Average # of ED visits annually • Average # of psychiatric acute care days annually • Average # of unplanned readmissions annually	• Increased % of at-risk clients with care managed through comprehensive electronic care planning functionality

Appendix D: User Requirements Survey Results

This appendix reports on one deployment of the User Requirements Survey at Hospital A.

Results Overview

- Total responses: 14
- Complete Reponses: 11
- Out of the 11 responses, 7 responses are from physicians who are all attending. The remaining 4 responses are from nurses.
- Because of the limited number of responses, I am not making any conclusions from the results.

The following sections present the answers from physicians and nurses separately. It also presents the answers that are related to a physician and a nurse about their experience with CPOE in a separate section.

Physicians' Answers

Section 1: *demographic information.*

- What is your age group? (in years)
  - 30-39 (4)
  - 40-49 (2)
  - 50-59 (1)

- If a physician, please specify specialty:
  - Family practice (1)
  - Mental/Behaviour health (1)
  - Pediatrics (1)
  - Emergency specialties (2)
  - Surgical specialties (2)

- What is your main setting? (Check only one)
  - Inpatient unit/ward: medical/ surgical (2)
  - Outpatient ambulatory clinic or specialist clinic (2)

    - Emergency Department (2)
    - Operating room (1)
- How many years of experience do you have as a practitioner?
    - Less than 5 (2)
    - 5-10 (3)
    - 16-20 (1)
    - More than 25 (1)

- How many hours do you work per week on average?
    - 24
    - 40
    - 45 (2)
    - 50-60
    - 60
    - 70

Section 2: *Self-reported computing and CPOE experience.*

- How would you rate your computer proficiency?
    - Average (7)

- Do you think a CPOE system is different from an Electronic Medical Record (EMR) or a clinic prescription system?
    - Yes (3)
    - No (1)
    - I don't know (3)

- Have you used a CPOE system before?
    - Yes (1)
    - No (6)

- In order to plan for a refresher and pretraining before the CPOE training, please rate your ability to perform the following tasks:

	Confident	Need Refresher	Not Sure	Not Applicable
Documenting patient information (e.g., history and physicals, progress notes)	3	2	0	2
Accessing clinical data (e.g., laboratory data, EKGs, radiology reports)	4	1	0	2
Communicating with healthcare team	3	2	0	2
Obtaining advice on specific patient's diagnosis or therapy	2	1	2	2

- How would you rate your frequency of using the new CPOE system? Why?
    - Frequent (2)
    - Infrequent (5)

- During you working hours, how many times do use/expect to use the CPOE system?
    - 0
    - 25
    - 20
    - Every day

Section 3: *Preferences and requirements.*

- How close should the training happen before the deployment (go-live)?
    - One month (5)

- I prefer to have training during
    - Weekday early morning (1)
    - Weekday during the day (0)
    - Lunch hour (4)
    - Weekday evening (1)
    - Weekend (1)

- In your opinion, what is the ideal training duration of each session
    - Less than an hour (0)

- One hour (3)
- Two hours (3)
- Three hours (0)
- Other (1) "depends on total time required, if 2 hours then prefer 2 hours rather than 2 one-hour sessions"

- Can you think of any special needs that should be accommodated with during training sessions? (if yes, please specify)
  - One answer: "should be able to trial in as near to live as possible, not so simple that when using actual product, it is more challenging"

- Would you like to have access to a test version prior to deployment?
  - Yes (4)
  - No (3)

- What communication channels do you prefer using to receive more information about the CPOE system?
  - Email (6)
  - Department meetings (2)
  - Regular meetings (1)
  - Newsletters (1)
  - Text messages (SMS) (1)

- If you need help for using the CPOE system, which sources would you prefer using?
  - IT support (7)
  - Colleagues (2)
  - Tutorials (2)
  - Online videos (2)
  - User documentation (1)
  - Help section (1)
  - Search Online (1)

Section 4: *Expectations and engagement.*

- What could hinder your acceptance of the CPOE system?
  - "needs to be user friendly and save time in order management"
  - "time-consuming (i.e. too many clicks) complicated not user friendly"
  - "If it makes me slower at my job"
  - "No formation out of office hours"
  - "slow to use ; hard to do routine work; loss of flexibility"

- What could facilitate your acceptance of the CPOE system?
  - "opposites of the above"
  - "If it is shown to make me faster on the job"
  - "if some processes are streamlined"

- What do you fear about the implementation of CPOE?
  - Time consuming in comparison to existing system (7)
  - Increase workload (6)
  - Jeopardize patient safety (2)
  - Interrupt interaction with patients (2)
  - Reduce number of patients seen (3)
  - Decline in salary (2)
  - Perceived individual benefits (1)
  - Inadequate training (2)
  - Lack of knowledge/confidence (2)
  - Loss of data (2)
  - Losing access to data when needed (2)
  - Other (1) "system rushed into place before it is ready (like at TOH)"

- Would additional involvement in CPOE implementation plan increase your acceptance level of the system?
  - Yes (4) Reason: "can debug (as we`re doing)"
  - No (3)

- How would you rate the following statements?

	Excellent	**Good**	**Average**	**Poor**	**Very poor**
F. Your motivation to pick up new skills to use a CPOE system effectively	1	1	4	0	1
G. Your opinion about the CPOE system's expected benefits to your organization	0	2	3	1	1
H. Your opinion about the CPOE system's expected benefits to you	1	0	4	1	1
I. Your current acceptance of the new CPOE system	1	0	5	1	0
J. Your feeling about having answered this survey as a means of getting involved in the CPOE implementation plan	0	1	5	0	1

- Do you have any other comments, suggestions, or concerns?
    - "implement gradually (like CHEO & not like TOH) to facilitate responding to problems as they crop up (instead of being flooding with an overwhelming number of problems) ... and continue to make useful responses to user problems ... and value people`s time - too much time at the computer means less time for other productive activities"

Nurses' Answers

Section 1: *demographic information.*

- What is your age group? (in years)
    - 18-29 (3)
    - 30-39 (1)

- What is your main setting? (Check only one)
    - Inpatient unit/ward: medical/ surgical (1)
    - Emergency Department (2)
    - Obstetrics (1)

- How many years of experience do you have as a practitioner?
    - Less than 5 (2)
    - 5-10 (1)
    - 11-15 (1)

- How many hours do you work per week on average?
    - 37
    - 37.5
    - 40
    - 50

Section 2: *Self-reported computing and CPOE experience.*

- How would you rate your computer proficiency?
    - Average (1)
    - Advanced (3)

- Do you think a CPOE system is different from an Electronic Medical Record (EMR) or a clinic prescription system?
    - Yes (2)
    - I don't know (2)

- Have you used a CPOE system before?
    - Yes (1)
    - No (3)

- In order to plan for a refresher and pretraining before the CPOE training, please rate your ability to perform the following tasks:

	Confident	**Need Refresher**	**Not Sure**	**Not Applicable**
Documenting patient information (e.g., history and physicals, progress notes)	4	0	0	0
Accessing clinical data (e.g., laboratory data, EKGs, radiology reports)	4	0	0	0
Communicating with healthcare team	4	0	0	0
Obtaining advice on specific patient's diagnosis or therapy	4	0	0	0

- How would you rate your frequency of using the new CPOE system? Why?
    - Frequent (3)
    - Infrequent (1)
        - Why?
            - "system is not in place in my work setting"
            - "Once we start using it, it will become standard of practice, as we process numerous orders on an hourly basis."
            - "in OB we often have verbal order. We do already use OM in Meditech for lab orders, diet and adm orders"

- During you working hours, how many times do use/expect to use the CPOE system?
    - "multiple times per hour, stating the number of times will be unreasonable."
    - Every day

Section 3: *Preferences and requirements.*

- How close should the training happen before the deployment (go-live)?
    - One month (3)
    - Three months (1)

- I prefer to have training during
    - Weekday early morning (2)
    - Weekday during the day (2)

- In your opinion, what is the ideal training duration of each session
    - Two hours (1)
    - Three hours (2)
    - Other (1) Eight hours

- Can you think of any special needs that should be accommodated with during training sessions? (if yes, please specify)
    - One answer: "Training material available from home, reading material to receive before which can help us prepare before the live training, and review once we leave the training."

- Would you like to have access to a test version prior to deployment?
    - Yes (3)
    - No (1)

- What communication channels do you prefer using to receive more information about the CPOE system?
    - Email (3)
    - Department meetings (3)
    - Newsletters (1)

- If you need help for using the CPOE system, which sources would you prefer using?
    - IT support (3)
    - Colleagues (4)
    - Tutorials (2)
    - Online videos (1)
    - User documentation (1)
    - Help section (2)

Section 4: *Expectations and engagement.*

- What could hinder your acceptance of the CPOE system?
    - "inaccurate order entries"
    - "I hope that the doctors use it consistently, instead of throwing us verbal orders. If used well by physicians, it will greatly advantage nursing"
    - "Difficult usage"

- What could facilitate your acceptance of the CPOE system?
    - "proper teaching and explanations on why this system should be in place"
    - "I am very ready and willing to accept this program."
    - "a good training and facility to use the program"

- What do you fear about the implementation of CPOE?
    - Time consuming in comparison to existing system (3)
    - Increase workload (2)

- Jeopardize patient safety (1)
- Perceived individual benefits (1)
- Inadequate training (4)
- Loss of data (1)
- Other (1) "I am looking forward to receiving training, as we have received none thus far, and it is only one month away. Incremental email blitz+communications will help adoption by staff."

- Would additional involvement in CPOE implementation plan increase your acceptance level of the system?
  - Yes (1)
  - No (3) Reason:
    i. "Lack of time at this moment"
    ii. "I was working with pcs optimization, I did learn a little bit about CPOE"

- How would you rate the following statements?

	Excellent	**Good**	**Average**	**Poor**	**Very poor**
K. Your motivation to pick up new skills to use a CPOE system effectively	3	1	0	0	0
L. Your opinion about the CPOE system's expected benefits to your organization	1	2	1	0	0
M. Your opinion about the CPOE system's expected benefits to you	1	3	0	0	0
N. Your current acceptance of the new CPOE system	2	2	0	0	0
O. Your feeling about having answered this survey as a means of getting involved in the CPOE implementation plan	0	2	2	0	0

Answers of Participants with Previous CPOE Experience

- One only physician has used CPOE before for less than a month in a hospital setting and does not recall the system name.
    - The physician did not have any training.
    - "medication ordering & finding rare things to order" was the most difficult to learn in the physician's opinion.
- One nurse has used EPIC CPOE system before in a hospital setting.
    - The nurse used the system for a period between 7 and 12 months.
    - The nurse has received a formal training.
    - "Order entry, because there are many steps that vary based on what we are entering" was the most difficult to learn in the nurse's opinion.

- From your previous experience with CPOE, how would you rate the following:

	Physician's ratings	**Nurse's ratings**
A. Your experience with the CPOE system, in general.	Poor	Good
B. Your ability to use the CPOE system.	Average	Average
C. The implementation process of CPOE.	Poor	Average
D. The consultation with users during CPOE implementation	Average	Average
E. The quality of the services (i.e. technical support and training services) provided for CPOE.	Average	Average
F. The level of training you had	Average	Average
G. The level of ongoing support provided	Average	Average
H. The level of CPOE team help.	Average	Average
I. The amount and quality of communication you received before CPOE implementation.	Average	Poor
J. The overall support for CPOE go-live	Average	Average

- From your previous experience with CPOE, please indicate the level of agreement or disagreement with each of the following:

	Physician's ratings	**Nurse's ratings**
A. I prefer using CPOE to traditional paper-based system	Moderately Disagree	Strongly Agree
B. Because of training received, I am more apt to use CPOE.	Moderately Disagree	Moderately Disagree
C. Because of communication used, I am more apt to use CPOE.	Moderately Disagree	Moderately Disagree
D. Because of my involvement in the implementation process, I am more apt to use CPOE.	Moderately Agree	Moderately Disagree
E. My fears were addressed before CPOE implementation.	Moderately Disagree	Not Applicable
F. I was well prepared to use CPOE	Not Applicable	Moderately Agree
G. I knew how to get help or who to ask if I have questions about CPOE	Not Applicable	Moderately Disagree

Appendix E: Online Material

Additional files developed in this thesis are available online at this location: https://www.site.uottawa.ca/~damyot/pub/Almoaber/Almoaber-2021-OnlineMaterial.zip

File	Explanation
Hospital A ethics approval (Hospital A Approval.pdf)	
University of Ottawa ethics approval (UOttawa Approval.pdf)	
CPOE Management Satisfaction Interview (Management Satisfaction Interview.docx)	Interview questions to measure the level of management satisfaction with the UCCM process
Invitation Letter (English Version) (Invitation Letter.docx)	A recruitment invitation letter that will be distributed to potential participants.
Invitation Letter (French Version) (Invitation Letter - F.docx)	Une lettre d'invitation au recrutement qui sera distribuée aux participants potentiels.
Consent Form (English Version) (General Consent Form.docx)	A consent form that will be handed to potential participants to read and sign before starting to answer the survey whether it's a questionnaire or an interview.
Consent Form (French Version) (General Consent Form - F.docx)	Un formulaire de consentement qui sera remis aux participants potentiels pour qu'ils le lisent et le signent avant de commencer à répondre à l'enquête, qu'il s'agisse d'un questionnaire ou d'un entretien.

Appendix F: Validation Meetings Summary

	Date	Location	Attendants Roles	Meeting's Goal(s)	Meeting's Result
1	16 May 2017	Hospital A	Director of Performance, Decision Support and Privacy	Exploring real problems related to implementing technology in hospital A	• The major problem was identified: technology-related projects have failed because of clinicians' resistance and refusal of using the implemented IT systems
2	30 April 2018	Hospital A	• Medical services director • IT manager	CPOE system implementation plan and current concerns	• The need for an effective approach to convince clinicians to accept and use the CPOE system was identified
3	7 Aug 2018	Hospital A	• A physician and CPOE lead in Hospital A • Medical services director	Early validation of the literature survey result and the content of the proposed process	• No major concerns regarding the UCCM process or the literature review • The UCCM process has been updated based on lessons learned from the current project issues

	Date	Location	Attendants Roles	Meeting's Goal(s)	Meeting's Result
4	22 Oct 2018	Hospital A	• A physician and successor CPOE lead in Hospital A • Medical services director	• A second validation of the content of the proposed process after updates. • Validation of the surveys	• No major concerns regarding the UCCM process • The UCCM process has been updated based on lessons learned from the current project issues • User requirement survey was updated to include some missing information
5	29 Mar 2019	Queensview CHAMP Office	• CPOE lead in CHAMP • Clinical lead for the CPOE • Clinical Informatics Coordinator • Medical services director of Hospital A	• CHAMP current CM approach • The feasibility of UCCM process and User requirement survey	• User requirement survey was updated to manage users' expectations • Suggestions to customize the survey to CHAMP
6	28-29 April 2019	Hospital A (By email)	• Chief medical informatics officer	• Validation of the user requirement survey	• User requirement survey was updated to include some missing information.

	Date	Location	Attendants Roles	Meeting's Goal(s)	Meeting's Result
7	26 June 2019	Queensview CHAMP Office	CPOE Physician Working Group meeting at CHAMP	Presenting the UCCM process and the User requirement survey to get: • Feedback on the process and the survey • buy-in to distribute survey in other CHAMP locations	• Suggestions to customize the survey to CHAMP