Designing a visual grammar to enable more effective stakeholder participation in scoping organizational change: A Physics of Notations Approach

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ABSTRACT

Successful organization change depends on effectively engaging impacted stakeholders early in the change process so that change leaders and stakeholders have a common understanding of the scope, benefits, and risks of the change. However, communicating a succinct and holistic view of the change and gaining shared understanding on what needs to change can be challenging. The use of sequential written communication and ad hoc graphics imposes a high cognitive load on stakeholders. This results in reluctance or inability for stakeholders to engage when their availability and mental resources are constrained due to operational demands. This research explores the design of a conceptual modeling grammar that generates single page, intuitive diagrams to reduce the cognitive load for stakeholders in understanding and defining the scope of organizational change. We first developed a domain ontology and a grammar based on theory. We then used the action design research approach to test and refine the grammar through three interventions in service delivery change in healthcare organizations. In each intervention we were able to overcome existing stakeholder engagement challenges and enhance stakeholder understanding of the scope of change being undertaken.

Keywords: conceptual modeling grammar, change management, physics of notations, action design research, stakeholder engagement

GENERAL SUMMARY

The rapid pace of change in the world is pressuring organizations to grapple with new ways of working and interacting. Organization change is most successful when everyone believes in the purpose of the change and has a common understanding of what needs to change early in the change process. Involving those most impacted by the change in figuring out exactly what to change helps uncover hidden gaps and builds as sense of ownership of and commitment to the success of the change. However, large scale organization change can be complex and getting everyone on the same page and contributing their ideas can take a lot of time and effort. Busy people with demanding operational responsibilities often feel they do not have the time to review written materials or attend workshops. And even when they do, they do not feel confident that they have the full picture and have identified all the gaps or impacts and so may be reluctant to commit to the change. This study used visual cognition research to develop a visual language that can be used to describe the purpose, scope and impact of organization change in single page diagrams. These diagrams are easy to understand and only take a few minutes to read. We tested and refined these diagrams with over seventy clinicians and administrators who wanted to change the way they delivered healthcare services. In each of our three studies, we were able to involve busy people to develop a common understanding of what needed to change and figure out how this would impact and benefit the way they worked.

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This thesis culminates a significant step in my quest to help the organizations with whom I work to respond to their rapidly changing environment and change they way they operate more successfully and with less stress on their members and constituents. Many people have supported and assisted me in this big step on my journey and for that I am deeply grateful.

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LIST OF ABBREVIATIONS

ADR Action Design Research

DSR Design Science Research

PoN Physics of Notations

EMR Electronic Medical Record

BPMN Business Process Modeling Notation

UML Universal Modeling Language

1 BACKGROUND

1.1 Introduction

Implementing organizational change is becoming increasingly necessary for organizations to sustain their existence and success (Al-Haddad & Kotnour, 2015) in a rapidly changing business environment. New technology, evolving customer expectations and the impacts of the recent COVID-19 pandemic are pushing organizations to deliver new types of service offerings and establish new ways of interacting with customers. However, despite decades of change management research and significant investments in change management tools and training, many organizations still struggle to achieve success in their change initiatives (Ashkenas, 2013; Burnes & Cooke, 2013; Decker et al., 2012).

A common root cause of failure in implementing new or transformed service delivery is under-scoping the extent of organizational change required to successfully achieve the desired outcomes (Burnes & Cooke, 2013; Greenhalgh & Stones, 2010), Under-scoping means that there is inadequate identification of the technological, structural, and social enablers critical to implementing and sustaining the change and achieving the desired outcomes. Insufficient understanding of the impact of the change across all involved stakeholders and resources leads to underestimating the scope and risks of the change. Under-scoping organizational change arises from not effectively engaging the right people with the knowledge to assess the various impacts of the change throughout the organization (Gioia & Chittipeddi, 1991; Hernes et al., 2015).

Much research has been performed in the area of motivation to engage in change preparation activities and on the topic of change communication content and methods. However, this research assumes that organization members have the necessary capacity to participate in the

engagement activities. The reality for many organizations is that many knowledgeable and motivated managers and staff have limited capacity to engage in a change initiative. Because they are motivated and competent, these organization members are often engaged in multiple change initiatives at the same time and have crucial operational roles and responsibilities. Increased pressure on willing yet time constrained individuals to engage in organizational change increases the stress on them and complicates their ability to manage the change (Huy, 2002).

The focus of this research is on stakeholder engagement and we use the general term "stakeholders" to refer to those who are directly impacted by the change. These stakeholders may be management, staff, fee for service (such as clinicians), customers, clients, or patients. We define direct impact as change to how the stakeholders perform their daily tasks and/or how they interact. We use the term "busy" to refer to heavy workloads that constrain the stakeholders' capacity to engage in change planning and preparation activities. This thesis explores a novel mechanism for decreasing the pressure and more effectively engaging motivated yet busy stakeholders in determining the extent and impact of organizational change.

1.2 Preliminary Literature Review

Executives generally set the direction for strategic change. They set financial goals, identify new technology to implement, determine new offerings to provide and decide on other structural changes. However, it is middle management and frontline staff who must operationalize the change by modifying the way of working in their units (Balogun, 2003; Bartunek & Woodman, 2015). They must understand the purpose of the change and then work out the details of all the changes. In addition, managers need to equip and prepare their staff to implement the new processes and efficiently use the new technology.

Collaboratively engaging executive, managers, and employees in determining and understanding the scope of change early in the change process can improve understanding of the change and its impacts across the organization (Balogun, 2003; Bartunek & Woodman, 2015; Sonenshein & Dholakia, 2012). This engagement can be more effective through including participatory learning and decision-making structures (Coch & French, 1947) as part of co-design activities (Steen et al., 2011) during the change scoping processes.

The organizational system of technology, processes and people is complex and interconnected and is difficult to convey. Using oral and written communication methods to gain understanding of these complex connections and the consequent impacts of proposed change can take significant time and mental energy. While it is executives' job to spend time setting the direction for the organization, managers and staff need to apply their time and energy to daily operations. This required commitment to their operational duties often leaves managers and staff with little spare capacity to participate in activities for providing input to the organizational change. "How could we more efficiently and more effectively engage busy managers and staff in determining the scope of organizational change" is the driving question behind this research.

Stakeholder participation in determining and designing change scope often includes verbal discussion and reviewing textual documents. Visual representations have been demonstrated to promote faster and more comprehensive understanding of a complex inter-connected system of things than does written text (Bauer & Johnson-Laird, 2016; Belova, 2006; Borghesani et al., 2016; Larkin & Simon, 1987). One reason for this is that the human brain has different systems for processing visual/graphical information and verbal/textual information. The visual system of the human brain is highly parallel, whereas the textual processing system is serial (Moody, 2009). Pictures have been used for centuries to convey ideas that are intuitively understood,

although often pictures lack detailed information. Spontaneously developed visual languages and diagrams have been used to engage stakeholders in co-designing implementation of service change (Overkamp & Ruijs, 2017) and other strategic organizational change (Kaplan, 2011; Paroutis et al., 2015; Zanin & Bagnoli, 2015). However, these languages are specific to the change initiative in which they are developed or are specific to an aspect of change such as technology or process. Thus, they are not generally reusable or do not include enough concepts to use for scoping all aspects of organizational change. The business process management and software engineering fields use diagrams extensively to convey process and technical design information, but the visual notation is often not intuitive. Significant training is required to comprehend the visual language used to generate those diagrams (Ottensooser et al., 2012).

When we look at operational change that involves new processes, new behaviours, new mindsets, new policies and potentially new technology, much research focuses on one or two of these aspects of change in isolation of the others. In addition, existing research on the use of visual tools focuses on how visual tools are used to define strategy or to design processes and technology. There is little research that explores how visual tools could be used more effectively to engage impacted stakeholders to design and integrate all aspects of organizational change. This study explores the opportunity for using visual tools to holistically scope organizational change and reduce the pressure on those individuals who participate in this engagement activity.

To perform this research, we developed a visual language and associated types of single page diagrams, that includes the appropriate vocabulary and is more intuitive then process modeling or software engineering diagrams. Unlike most existing process modeling and software engineering visual languages, we founded the design of this visual language on visual cognition and conceptual modeling theories. We also involved some potential users of the language in

testing and enhancing its design. Because our research was focused on developing a new visual tool, we utilized the Design Science Research approach to structure the research process and evaluate the design and impact of the visual language.

1.3 Design Science Research Approach

Design science research (DSR) has been described as a method to solve recognized problems "in unique or innovative ways" by introducing artifacts into the system (Gregor & Hevner, 2013). Rather than studying what already exists, DSR takes an abductive approach to design and develop new artifacts to solve existing problems (Venable et al., 2016). Once the problem is identified, a search is made for theories that be can used to understand the problem, identify potential solutions, and design artifacts to implement a solution (Hevner et al., 2004). These theories are applied and potentially expanded through multiple design and evaluation iterations of the artifact. New theories may be sourced or developed to fill gaps discovered during design (Gregor & Hevner, 2013). DSR in the context of organizations can be described as a method to solve organizational problems through the creation and evaluation of useful artifacts and the formulation or extension of design theory that can be used to construct other similar artifacts (Hevner et al., 2004). DSR methods enable the rapid cycles of build, implementation and evaluation that contribute to the design itself and to design theory (Venable et al., 2016).

March and Smith (1995) outlined a research framework for information systems that implements the DSR approach. This framework is useful to describe the research process and outputs of the study described in this thesis because, although the visual language developed in this study is not a computerized system, it is a form of an information system that enables recording and communication of information. March and Smith's framework has two axes, research outputs and research activities, each with discrete components (Figure 1). The

horizontal axis identifies four types of research activities. The first two types, build and evaluate, are within the realm of design science research.

The purpose of the build stage is to demonstrate that the artifact(s) can be constructed in a feasible manner. The build stage involves the design and the construction of the artifact. The vertical axis identifies four types of design science research outputs or artifacts that can be built: construct, model, method, and instantiation. The artifacts in a visual language can be directly mapped to these four types.

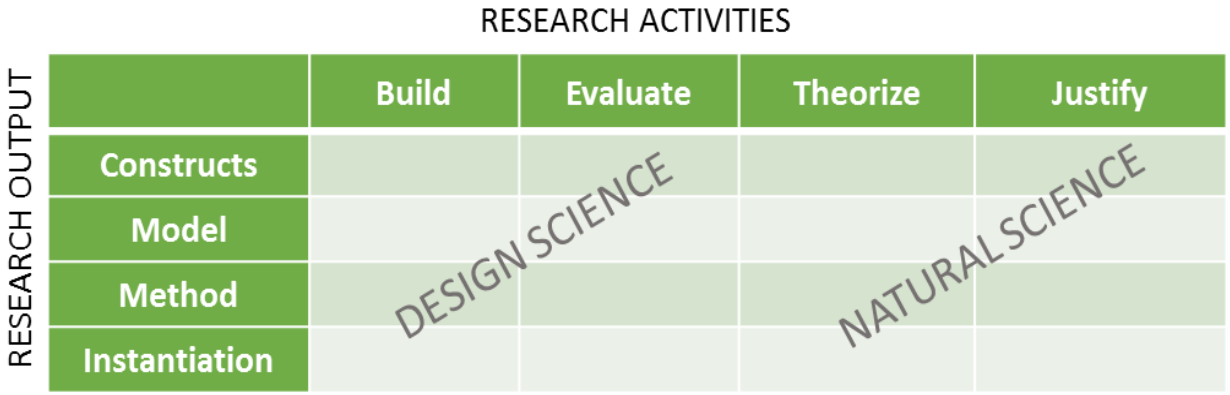


Figure 1 – Design Science Research Framework (March & Smith 1995)

Constructs describe the semantic vocabulary of the domain and the associated visual symbols (March & Smith, 1995). Models describe the relationships between the constructs (March & Smith, 1995). Methods are algorithms, procedures, or guidelines that may be used to facilitate construction of an instantiation of a diagram. A diagram is a working artifact (March & Smith, 1995).

1.3.1 Problem & Potential Solution Identification

The essential first step for effective design science research is to define a clear problem statement. The problem statement should be general enough to be relevant across multiple

organizations. It should also be specific enough to support clearly defined evaluation criteria for the utility and efficacy of the artifact being designed (Peffers et al., 2014). A problem statement can be decomposed into a problem space and a business need (Hevner et al., 2004). A problem space is the environment of the phenomena of interest. It includes the organization, the people and the goals, tasks, problems, and opportunities that define the business need (Hevner et al., 2004). The problem space for this research includes organization members, with the problem of constrained availability of time and mental energy, executing the task of determining the scope of change to service delivery, with the goal of doing this collaboratively to ensure effective change outcomes for everyone. The business need in this study is a communication tool and method that enables people to accomplish this task and achieve this goal within their availability constraints.

We propose an intuitive visual language as a potential solution to address this business need within this problem space. This proposal is built on both practical and theoretical evidence. The practical justification is the broad usage of conceptual modeling grammars for process and software modeling and the growing popularity of diagrams, such as the balanced score card, business model canvas, and value proposition canvas for scoping strategy and business models. The theoretical justification is twofold. The literature on visual cognition demonstrates how the human brain can process graphical representations of complex models much more quickly and with less cognitive effort than textual representations (Bauer & Johnson-Laird, 1993; Belova, 2006; Borghesani et al., 2016; Larkin & Simon, 1987). Building on visual cognition theories, the literature on the characteristics of effective notations, such as Moody's (2009) "Physics of Notations", provides the theoretical basis for the design of the language's notation.

1.3.2 Theory-based Design

We started the design process of the visual language with a search for theories that would help answer the first research question:

> *RQ1: What constructs of a visual language would enable people in an organization to effectively comprehend and cooperatively determine the scope of organizational change with minimal explanation of the language?*

To answer this research question, we looked first to the literature on conceptual modeling to understand the components of a visual language. The visual language developed during this research consists of a set of diagram types and the underlying common structure and rules for the components and layouts of the diagrams. A diagram is defined in the information systems discipline as a graphical representation of a conceptual model which is meant to facilitate understanding and communication of complex patterns of physical or social reality for a specific purpose (Evermann & Wand, 2005; Wand & Weber, 2002). A diagram type defines the layout and communication purpose of a diagram. We defined conceptual modeling methods for each diagram type in our visual language. Moody (2009) further decomposes a conceptual modeling grammar into syntax and semantics. The semantic constructs and rules comprise the meta-model which describes the content of the domain. The syntactical constructs refer to the graphical symbols which visually represent the semantic constructs. The graphical composition rules comprise the visual notation used to generate diagrams. Moody's "Physics of Notations" (2009) theory identifies the need for a one to one mapping of semantic constructs to graphical symbols to ensure effective comprehension of the language. This means a clearly defined meta-model or domain ontology which defines the concepts of the domain is essential.

An ontology represents a world view as a set of defined concepts and the inter-relationships between these concepts. This defined representation enables the integration of different partial views of the domain (Uschold & Gruninger, 1996) held by different stakeholders within the domain. Thus, a domain ontology provides a unifying framework that reduces conceptual confusion and enables people to develop a common understanding of the domain (Pinto & Martins, 2004; Uschold & Gruninger, 1996). Therefore, a domain ontology for organizational change scope can provide a consistent and coherent basis for different stakeholders to determine the scope of change. Extensive research relevant to scoping organizational change has been performed within the organizational change, strategy execution and information systems disciplines. However, different terminology and sometimes inconsistent concept definitions are used across these disciplines.

We were unable to find a unified domain ontology for scoping organizational change in the literature that we reviewed. This is likely because organization change scope is partially addressed in diverse streams of literature including strategy, information systems, business process management, organization structure and organization behaviour. Therefore, our first task was to develop such an ontology. To complete this step, we performed an extensive literature review to identify and define the potential concepts necessary to describe the scope of change to service delivery. We started by searching the information systems discipline for methods to define a domain ontology. There are numerous methods for building a domain ontology (da Silva et al., 2012; Gargouri & Jaziri, 2010; Pinto & Martins, 2004). The choice of method depends largely on the purpose of the ontology and the level of formality required (Gargouri & Jaziri, 2010; Uschold & Gruninger, 1996). Uschold and Gruninger (1996) outlined a methodology that integrated their previous individual methods used to developed ontologies for describing an

enterprise. This method has been used by Uschold, Gruninger and others, such as Osterwalder (2004), to define formal and semi-formal domain ontologies relevant to organizations. Thus, it is a suitable choice to guide the development of domain ontology for the scope of organizational change. This method includes processes to (a) to bound the scope of the ontology; (b) identify the constructs and their relationships and develop construct definitions; (c) test the ontology; and (d) document the ontology.

A literature review, guided by structuration theory and sense-making theory, was conducted across the domains of organizational change, strategy execution and information systems to identify the pertinent semantic constructs and develop their definitions. We then returned to complete the literature review on conceptual modeling and defined the first iteration of each of the components of the conceptual modeling grammar and modeling methods.

1.3.3 Artifact Practical Design and Evaluation

At this point we searched the design science literature for a method to evaluate and improve the design of the visual language and developed our second research question:

> *RQ2: How does the use of this visual language affect the engagement of busy individuals in defining or communicating the scope of change in an organization?*

We selected the Action Design Research (ADR) method (Sein et al., 2011) to answer this question. ADR designs the artifact, develops, and uses instances of the artifact, and evaluates both the design and usage within the context of an organization intervention. The advantage of ADR is that artifact design and evaluation is guided by theory and practitioner input and employs a form of iterative participatory design. ADR also enables the artifact design to be validated and refined through actual use in a relevant situation.

This approach of interleaving theoretical guidance and practitioner input was executed iteratively as depicted in Figure 2. We started with a theory-based design iteration for each of the domain ontology, the conceptual modeling grammar and modeling methods to promote the theoretical soundness of each of these three artifacts. To ensure the practical utility and efficacy of these artifacts we then continued with design and evaluation in the context of three healthcare organizational change initiatives.

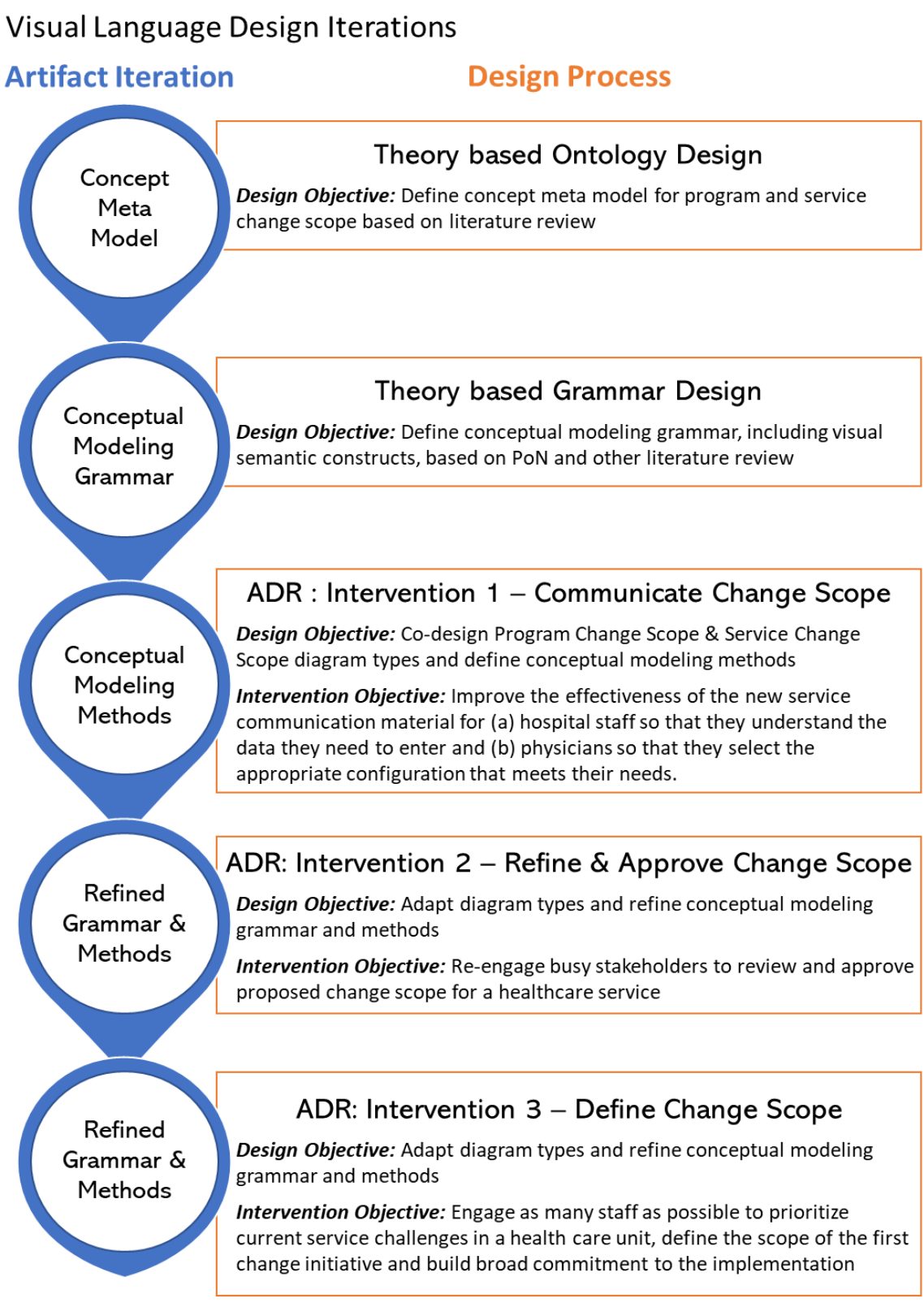


Figure 2 - Design Iterations: Artifacts, Process & Objectives

We defined and evaluated design objectives for each design iteration to guide the scope and quality of the design. We also defined practical intervention objectives for each intervention and used these to evaluate the utility and efficacy of the artifacts. Healthcare change initiatives were selected because staff availability to engage in scoping change is typically very constrained in healthcare organizations. Two of the initiatives were already encountering staff availability and communication challenges defining the scope of change and the third initiative had not yet started.

Given that the purpose of the visual language artifacts was to improve communication and understanding of the extent of required process change, we extensively used qualitative data collection and analysis methods, including observation, semi-structured interviews, and ethnographic reflection. Using these various qualitative methods enabled triangulation of multiples types of data sources and various data collection methods. This triangulation improved the validity of the findings on the extent and ease of understanding and communication that was enabled by the diagrams developed using the conceptual modeling grammar. The rich descriptions from myself as the researcher, and from the other observers, along with the results of participant interviews also provided insights into why or why not particular design features were effective. These insights enabled iterative identification of enhancements to the design of the conceptual modeling grammar and modeling methods and identified where refinements to the domain ontology were needed.

1.4 Research Contribution

Design science research generally contributes to the body of prescriptive knowledge rather than descriptive knowledge. Descriptive knowledge includes the classification and measurement of phenomena and the definition of natural laws, principles, and theories of how these

phenomena operate. Contribution to prescriptive knowledge can occur at three different levels ranging from the first level of specific, limited and less mature knowledge to the third level of abstract, complete, and mature knowledge (Gregor & Hevner, 2013, p.340). Level one knowledge is provided through artifacts implemented in a specific situation. This research project contributes level one knowledge consisting of instances of diagrams developed for specific change management situations with a purpose of engaging busy individuals. Level two knowledge is defined in operational or design principles and includes constructs, methods, models, and design principles (Gregor & Hevner, 2013). This research contributes level two knowledge in the form of a domain ontology for scoping organizational change (semantic constructs within a meta-model), the conceptual modeling grammar (visual syntactic constructs) and the conceptual modeling methods (diagram types with diagram design principles). To ensure clarity and rigor in the level two knowledge contributions we followed the framework for elucidating design principles outlined in Gregor, Chandra, Kruse, and Seidel's (2020) *Anatomy of a Design Principle*. Level three knowledge consists of mid-range design theory. This research contributes level three knowledge by extending Moody's (2009) mid-range notation design theory to include more principles on using physical symbol positioning and graphical characteristics as a method to reflect relationships between semantic constructs. We also validated a few of the design principles defined in the *Physics of Diagrams* (Pissierssens et al., 2019).

Since the purpose of this research was to design a visual language to improve communication and decision making in scoping organizational change within limited capacity constraints, it was important to contribute valuable knowledge to practitioners. Design theories, including design principles, are abstract prescriptions intended to help practitioners achieve

specific goals. The design theories and sample tools developed in this research can help practitioners effectively engage busy stakeholders in co-designing the scope of organizational change. To increase the reliability and value of our knowledge contributions to practitioners we considered the dimensions of design theory indeterminacy (Lukyanenko & Parsons, 2020) during the development, use and evaluation of the visual language as well as in the manner in which we documented the research outputs.

1.5 Thesis Structure

The visual language designed in this research is comprised of three distinct artifacts: the domain ontology, the conceptual modeling grammar, and the conceptual modeling methods. Each artifact was abductively and iteratively developed using a distinct design research method and various kernel theories. This abductive, iterative pattern is reflected in the structure of this thesis.

Chapter 2: Domain Ontology – Method and Constructs starts with an explanation of the method used to construct the domain ontology, along with initial definition of the ontology and the theoretical basis for each concept definition. It continues with a description of the theoretical lens used to search the literature for concepts relevant to the domain. This definition of the domain ontology remained largely intact throughout the organization interventions with only a few modifications.

Chapter 3: Conceptual Modeling Grammar and Modeling Methods describes the theoretical basis for the design of the conceptual modeling grammar and modeling methods. It provides a brief review of existing popular conceptual modeling grammars and a justification of why a new modeling grammar is required. The initial design of the syntactical constructs is detailed along with an initial set of common design principles for the layout of the diagrams.

Chapter 4: Action Design Research Method describes the ADR method in detail and how it was applied within the three organizational interventions in this study. This chapter also describes the data collection methods, how the data were analyzed, and the approach to evaluating the design of the artifacts.

Chapter 5: Interventions describes the process and findings of each research intervention in turn. Each intervention description begins with the purpose and structure of the organizational intervention and continues with an explanation of how the artifacts were further developed, used, and evaluated in collaboration with the intervention participants. Examples of the generated diagrams are provided and discussed. A summary of the findings from the evaluation of the grammar and the use of the generated diagrams concludes each intervention story.

Chapter 6: Discussion and Conclusion discusses how the design and instantiation of the diagrams answered the research questions and summarizes the evaluation of the design of the visual language. This chapter also identifies corresponding research limitations. The thesis concludes by summarizing the contributions to academic research and organizational change practice and identifying areas for further research.

2 SCOPING ORGANIZATIONAL CHANGE – CORE CONCEPTS

2.1 Search for a domain ontology

Identifying the scope of organizational change to delivery of services is an important aspect of organizational change strategy (Al-Haddad & Kotnour, 2015). There are various academic streams that focus on one or more aspects of organizational change, such as organizational development, change management, strategy execution, and management information systems. Each of these streams uses a variety of concepts and many papers do not define the terms they are using. For example, the concept of change "outcome" is used variously to describe the purpose of the change, where it is used interchangeably with the term "goal (Burke, 2002). The term "outcome" is also used in reference to the results of the change (Volberda et al., 2010) and/or the effects of the change (Balogun & Johnson, 2005; Bartunek et al., 2006; Orlikowski, 2000). However, in some literature "outcome" is explicitly distinguished from "goal" (Balogun & Johnson, 2005).

In addition, most literature focuses on a specific aspect of the scope of change such as culture and behaviour, process and technology, offerings and services, activities, and outcomes. In searching the literature on strategy execution and change management, I did not find a unified definition of concepts covering the full scope of organizational change or specifically service delivery change. The literature on semi-formal ontologies in the information systems stream does define ontologies specific to an aspect of organizational change, such as the strategic planning process (Dalmau Espert et al., 2015), service modeling (Falbo et al., 2016), value propositions (Sales et al., 2017) and value ascription (Guarino et al., 2016). However, I did not find a domain ontology encompassing the scope of organization change.

Practitioner literature suffers similar challenges. The Association of Change Management Professionals' (ACMP) global change management standard (ACMP, 2014) attempts to provide a standard view of organizational change. It identifies and defines many of the key concepts for organizational change. However, it suffers from internal inconsistency. For example, change "benefit" is defined as "The quantitative and qualitative, measurable and non-measurable outcomes resulting from a change" (ACMP, 2014, p.9), but an "outcome" is defined as "a specific measurable result or effect of an action or situation" (p.10) and does not define the relationships between concepts. The ACMP standard references the "scope of change" numerous times but does not attempt to define the composition of the scope of change. This variation of concepts and terminology and lack of common definitions amongst practitioners and academics leads to partial and potentially dissonant views of the scope of organizational change.

A domain ontology provides a unifying framework that reduces conceptual confusion and enables people to develop a common understanding of the domain (Pinto & Martins, 2004; Uschold & Gruninger, 1996). A domain ontology represents a worldview as a set of defined concepts and the interrelationships between these concepts. This defined representation enables the integration of different partial views of the domain (Uschold & Gruninger, 1996) into a coherent mental framework for understanding the domain.

This chapter develops an initial domain ontology for articulating the scope of technological and process change within an organization. The next section in this chapter explains the established method used to develop the domain ontology. This is followed by the definition of the boundaries of the set of required concepts. The remaining sections in this chapter elaborate descriptions of each of the core concepts and their relationships.

2.2 How the ontology was developed

There are numerous methods for building a domain ontology (Gargouri & Jaziri, 2010; Pinto & Martins, 2004; Souza et al., 2012). The choice of method depends largely on the purpose and subject matter of the ontology (Gargouri & Jaziri, 2010; Uschold & Gruninger, 1996). An ontology to be implemented by computer software needs to be formally defined with precise axioms. On the other hand, an ontology to be used as a glossary for human communication can be informally defined using natural language (Uschold, 1996). Many methods, such at TOVE, ENTERPRISE and the METHONTOLOGY framework are focused on building formal ontologies. However, Uschold and Gruninger (1996) outlined a four-stage methodology that integrates and expands their TOVE and ENTERPRISE methods and provides a comprehensive and flexible framework for defining an ontology at various levels of formality from informal to axiomatic. Since we are not implementing this ontology in a computer system, axiomatic formality is not required (Uschold, 1996). However, natural language is too loose for purpose of defining an ontology for a visual language. To enable one to one mapping of semantic constructs to visual constructs, a semi-formal ontology with unambiguous concept definitions and clearly defined concept relations is required. Uschold and Gruninger's method supports the development of a semi-formal ontology and it has been used to define domain ontologies for describing various aspects of organizations. Thus, it is a suitable choice to guide the development of a domain ontology that supports a visual language for scoping organizational change. The following sub-sections outline how the four stages of Uschold and Gruninger's (1996) methodology were applied in developing the initial domain ontology.

2.2.1 Stage 1: Identify Purpose and Scope

The first stage in defining a domain ontology is to determine the purpose of the ontology and the scope of the domain. This step is critical because it defines the boundaries for the ontology and determines the appropriate level of formal description (Uschold & Gruninger, 1996). The purpose of the domain ontology defined in this research is two-fold. First, this ontology provides a set of concepts that can be used by people to describe the scope of change to service delivery. Second, this ontology provides the semantic meta-model to support the definition of a visual grammar for depicting organizational change scope. A structured informal definition enables natural human communication and the one-to-one mapping of semantic constructs to visual constructs within a conceptual modeling grammar (Uschold, 1996). A structured informal definition includes an unambiguous definition of each concept using natural language and a structured description of the relationships between the concepts and identification of the cardinality and modality of those relationships.

2.2.2 Stage 2: Build the Ontology

The second stage is to build the ontology. There are two tasks required to define an ontology with a medium level of formality. The first task is to identify the potential key concepts and concept relationships in the domain. This first step starts with defining general scenarios to create an initial boundary for the scope of concepts to include in the ontology (Uschold & Gruninger, 1996). A general scenario describes the context and high-level process within which the concepts would be found. General scenarios can be developed from literature for broad domains or based on a practical problem or set of tasks for narrowly specific domains. Organizational change scope is a broad domain; thus, we created the general scenarios from a literature review.

The various aspects of each general scenario are then explored by developing general competency questions about the scenario and generating descriptive answers to these questions. A competency question asks "what" happens within the general scenario and "what" resources and expertise are needed. There are three approaches to constructing the general competency questions: top-down, bottom-up, middle-out. A top-down approach starts with a top-level concept and iteratively decomposes it into more primitive concepts. This approach would start with a question such as, "what is an organization?" The disadvantage to this approach is that the resulting scope of the ontology is extremely broad, and work must subsequently be performed to reduce the ontology to focus on the specific domain. The bottom-up approach starts with collecting and creating as many potentially relevant questions and descriptive answers as possible, using literature review and potentially brainstorming. The answers are then analyzed for relevance, duplication, and overlap. This approach is very time consuming and the results can be very subjective unless enough researchers are involved to ensure multiple perspectives are considered and consolidated in a reliable manner. Uschold and Gruninger (1996) recommend taking a middle-out approach, which is the approach taken in this research. This approach is iteratively abductive. It starts with a literature review on broad questions relevant to the general scenarios, such as, "What contributes to the success of the scenario?" Then subsequent competency questions are created to dive deeper into the first set of answers and a further literature review performed to find the next set of answers. One advantage of this approach is that the competency questions are iteratively developed and informed by literature review, which improves the relevance and the reliability of the questions. A second advantage is that focus on the domain is maintained throughout the iterative process, which reduces the work to weed out irrelevant or overlapping questions at the end.

As the responses to each iteration of the general competency questions are developed, the key concepts are then identified from within these responses. This ensures the relevancy of the concepts in the domain ontology. In addition, during each iteration and again after the first draft of all concepts were identified, I also applied Uschold and Gruninger's (1996) concept definition guidelines to ensure clarity, consistency, coherence, and parsimony. These guidelines include avoiding circularity, avoiding new terms not commonly used, avoiding ambiguous terms by identifying the underlying concept, and avoiding excessively narrow definitions that result in multiple similar terms.

The second task in building an ontology is to produce unambiguous text definitions for each identified concept. In the initial iteration of the ontology, literature sources were used to develop the definitions. This enabled the use of common terms and definitions as much as possible. It also enabled underlying concepts to be identified from similar concepts across different literatures. The ontology presented here synthesizes concept definitions from existing domain ontologies, change management literature and literature from other related domains, such as strategy in practice and requirements engineering. The change management terminology and definitions published by the Association of Change Management Professionals (2014) was also considered to reduce dissonance with practitioner usage of terms where possible.

The two tasks described above were applied iteratively. First, a set of core concepts was identified. Then, as concept definitions were developed, some concepts were merged, and a few additional concepts were identified. For example, in the initial core set of concepts we identified goal, outcome and design requirement. As I researched additional literature across requirements engineering and outcome management, I merged these concepts. Outcome and design requirement were defined as sub-types of goal. I also added performance as sub-type of goal.

Figure 3 at the conclusion of this chapter, depicts the meta-model describing the concepts and relationships defined in this domain ontology.

2.2.3 Stage 3: Test the Ontology

The third stage verifies the internal and external consistency of the ontology. The relationships between the concepts were theoretically tested by defining and applying detailed competency questions about the concepts. This was performed to ensure there were no gaps or overlapping concepts and relationships. The ontology was additionally tested by using it as a framework for the concepts depicted by the visual grammar which was developed and used in the context of the three organizational interventions.

2.2.4 Stage 4: Document the Ontology

The final stage assembles the complete documentation for the ontology. Documentation for a semi-formal ontology includes the natural language definitions of all concepts and their relationships with each other. The final part of this chapter documents the initial set of concepts and includes a graphical view summarizing the domain meta-model (i.e. identification of concepts and significant concept relationships). The resulting modifications made to the ontology after testing it within the three organization interventions are described in Chapter 5.

2.3 Bounding the Set of Concepts

As described above, defining general scenarios for the use of the ontology is an objective way to bound the relevant scope of the concepts (Uschold, 1996). Organizational change is a large topic with potentially numerous concepts. To manage the scope of this research, I limited the focus of the scope of organizational change to service delivery change within an organization. General organizational culture change, human resource systems of incentives and rewards, and change leadership capability development were not included, although these also

are recognized as critical enablers of organizational change. I started my search for pertinent concepts by looking to organizational change literature to identify relevant general scenarios.

Research into complex technological and process change, such as the introduction of electronic medical records in healthcare, or integrated information and workflow systems in other organizations, has identified some critical success factors for scoping organizational change. The first critical success factor is integration of the various macro (organization), meso (department or team) and micro (individual) perspectives on the motivation for and the scope of the change (Greenhalgh & Stones, 2010; Lüscher & Lewis, 2008). Senior leaders may understand the macro level perspective but will likely not be intimately aware of the multitude of meso and micro level perspectives (Floyd & Lane, 2000). Senior leaders may also not be aware of the reciprocal impact of technology changes on process changes. When people discover new opportunities to use technology to improve the way they work in their individual and team interactions, they will often then identify technology improvements to better fit the newly envisioned workflow (DeSanctis & Poole, 1994; Stones, 2005).

The second critical success factor to appropriately scoping organizational change builds on the first one, by incorporating participative learning into the change process (Gioia & Chittipeddi, 1991; Lines, 2004). When people are engaged in participative learning and decision making with feedback loops across all levels of the organization, they can develop a more comprehensive understanding of the various macro, meso and micro perspectives of the change (Gioia & Chittipeddi, 1991; Lines, 2004; Sassen, 2009). This enables change leaders to develop (a) a better understanding of the forces promoting and inhibiting the change at all three levels; and (b) a more comprehensive identification of what needs to change to strengthen promoting

forces and to mitigate inhibiting forces at all three levels (Balogun, 2003; Fuchs & Prouska, 2014; Greenhalgh et al., 2014; Lewin, 1947).

Theories of sensemaking within organizations (Weick et al., 2005) can be used to provide a framework for understanding how the macro, meso, and micro perspectives of organizational change develop and interact. Individual sensemaking naturally occurs when the environment is new, unexpected, or unknown (Gioia & Chittipeddi, 1991), such as starting a new job, losing a boss or being required to use new technology. Sensemaking in the context of organizational change is also a group social process (Wieck et al., 2005). The shared experience of anticipating and implementing change often results in co-operative or shared sense making amongst the members of the group. In this context sense making is the process of understanding the purpose of the change and the impacts on one's self and the groups of which one is a member, and then individually and collectively determining how to respond to the change (Gioia & Chittipeddi, 1991; Narayanan et al., 2011; Weick et al., 2005). This understanding of the change and determined response influence individual and group behaviour. These behaviours in turn influence the way the organization works (Jones et al., 2008; Stones, 2005), moving the organization towards or away from the intended change (Lewin, 1947). Thus, it can be said that "organization emerges through sensemaking" (Weick et al., 2005, p.410). This means the actual implementation of organizational change emerges and evolves as people make increasingly greater sense of the change.

A consistent implementation of change that moves the organization towards intended outcomes can be aided by facilitating and guiding the organizational sensemaking processes. We applied this social sensemaking perspective with the above two critical success factors to define the two general scenarios for the organization change domain ontology. Each scenario describes

a social process within the organization whereby organization members understand what should change and discover how to implement the change at the macro, meso and micro levels.

The first scenario is engaging change leaders and impacted stakeholder groups in determining the scope of the change. This scenario covers the collaborative analysis and identification of:

- the macro, meso and micro purpose of an anticipated service change in the organization; and
- the required extent of the change and resulting potential impacts.

The second scenario is engaging all other affected stakeholders in understanding the purpose, extent and impacts of the change to promote and enable stakeholder participation in successfully implementing the change.

Both these scenarios commence with understanding the purpose of the change. Sensemaking involves both retrospective and prospective thinking (Weick et. al., 2005). Organization leaders reflects on past achievements, current opportunities and threats, and envision future achievements. They then determine what needs to change in the organization to accomplish those future achievements. Individuals reflect on the described future change and their current situation and then determine how they will respond, either in making or resisting the change (Narayanan et al., 2011). By applying the sensemaking perspective we can frame both scenarios by answering the same two sensemaking interrogatives - why (the purpose) and what (the extent and impacts). Therefore, we defined a single set of general competency questions elaborating these two interrogatives through the macro (organization change purpose and scope),

meso (department or group change purpose and impact) and micro (individual change purpose and behaviour) levels for both scenarios.

2.3.1 General Scenarios for "Why Change?"

Planned organizational change is usually preceded by development of a strategy (Burke, 2017) that responds to changes in the organization's environment or to internal challenges (Caulfield & Senger, 2017; Narayanan et al., 2011; Tushman & O'Reilly, 1996). Recognition of threats and opportunities initiates the macro sensemaking process for organization leaders (Narayanan et al., 2011; Weick et al., 2005). To achieve the best return on the change investment, the scope of the change should ideally be just enough to enable achievement of the strategy that is driving the change. When strategic goals are defined to measure achievement of the strategy, the scope of change can be derived from identifying what needs to change to achieve the strategic goals (Burke, 2017). In addition, any changes to the processes and resources to measure these goals should be included in the scope of change (ACMP, 2014). The strengths, weaknesses, opportunities and threats framework (Bell & Rochford, 2016) and external stakeholder value models (Frow & Payne, 2011) from strategy literature were used as guides for defining the competency questions focused on the macro perspective of why the organizational change is occurring:

- What are the external opportunities (Bell & Rochford, 2016) to deliver more value to external stakeholders (Frow & Payne, 2011)?
    - Who are the external stakeholders?
    - What additional value can be delivered to them?

- What are the external threats or internal weaknesses that may increase costs, reduce revenue or market share (Bell & Rochford, 2016), or reduce stakeholder value (Frow & Payne, 2011)?
- What are the strategic goals determined in response to the opportunities and/or threats driving the change (Daly, 1995)?
    - What are the indicators that reflect and measure the achievement of these goals (ACMP, 2014; Boswell & Boudreau, 2001)?

To promote stakeholder commitment to the change as described in the second general scenario, the answer to "why change" also needs to be considered from meso and micro perspectives. Theories specific to the impact of the involvement of groups and individuals in organizational change began to formally take shape in the 1940's. Lewin (1945, 1947) was an early proponent of researching "the conditions of group life and the forces which bring about change or which resist change" (p130). Coch and French (1947) built on Lewin's propositions and identified that the processes and group structures put in place by change leaders to manage the change also impacted employee adoption of change. Specifically, they found that encouraging participative group decision-making in the change process resulted in far less employee resistance than occurred when change was imposed. Lines (2004) found that there was better achievement of change goals and increased commitment to sustain the change when people participated in decision making processes during the change process and contributed their micro and meso perspectives. This was partially because participating effectively in decisions required and enabled a deeper understanding of the business system and the drivers for change (Boswell & Boudreau, 2001; Lines, 2004). When those impacted by the change better understand the reasons for the change and the positive benefits for themselves, they can make coherent sense

of the change and align their actions to achieve the change goals (Daly, 1995; Sonenshein & Dholakia, 2012).

Understanding the reason for the change also enables people to identify new opportunities for doing things differently and more effectively (Boswell & Boudreau, 2001; DeSanctis & Poole, 1994; Stones, 2005). This understanding and insight results in more relevant and effective change preparation planning at the meso level and change design input at the meso and micro levels (Lines, 2004). This in turn leads to fewer gaps in the initial scoping of change, along with more effective change design and implementation decisions. Building on people's insight and ideas when scoping the change also develops their ownership of the change (Barki et al., 2008). This leads to their greater commitment to the success of the change (Pierce et al., 2001).

Sensemaking literature again provided a useful framework for identifying general competency questions around "why change", this time from the meso and micro perspective of individual members of the organization (Gioia & Chittipeddi, 1991; Seligman, 2006; Weick et al., 2005). This set of questions starts with:

- Who are the internal stakeholders impacted by the change?
- What benefits might they receive from the change?

Benefits finding is another meaning-making process deemed necessary by social psychologists for coping with major life events. Benefits finding can be used in the context of organizational change to describe the process where individuals discover beneficial results of the change, that they perceive as outweighing the downsides of the change. Benefits finding and organizational change literature also recognizes that not all external and internal stakeholders value a benefit in the same way (Frow & Payne, 2011; Jones et al., 2008; Sonenshein &

Dholakia, 2012). For example, an increase in job responsibility could be perceived as highly valuable by someone aggressively pursuing career growth but perceived as only slightly valuable for someone interested in maintaining status quo. In addition, what may be perceived as a benefit by one stakeholder, for example decreased time to perform a task, may be perceived as a detriment by another stakeholder who enjoys performing the task and receives social or emotional value from the current manner of performing the task.

Thus, a benefit of change can be decomposed into two concepts: an outcome of the change (Al-Haddad & Kotnour, 2015; Narayanan et al., 2011); and the perceived value of that outcome (Frow & Payne, 2011). The failure of change leaders to distinguish between an outcome and the perceived value of that outcome leads to incorrect assumptions regarding the willingness of stakeholders to change (Sonenshein & Dholakia, 2012). These incorrect assumptions based on a change leader's own perceptions of value can lead to unexpected pockets of resistance amongst impacted stakeholders. Breaking down the question regarding benefits leads to replacing the previously defined general competency question with the following two questions:

- What are the direct outcomes of the change for stakeholders?
- What is the value perceived by various stakeholders of those outcomes?

When change leaders understand the change outcomes that are most valued by impacted stakeholders, they can prioritize the scope of change to encourage maximum adoption. For example, if a small technology feature will enable an outcome that is highly valued by certain stakeholders who can significantly influence the success of the change, then that feature can be prioritized for design input from those stakeholders and its survival ensured during any project scoping cuts. Conversely, the inclusion of anything that is perceived by stakeholders to decrease

the value or increase the cost of the change may become a risk to stakeholder adoption and thus a demotivating factor of change. This raises another question around perceived value.

- What stakeholder perceptions create a potential stakeholder adoption risk by reducing the value of the change or increasing the cost of the change to the stakeholder?

At the early stage of scoping organizational change, direct outcomes will be intended since they can only be envisioned and not measured. Thus, at this point they can be considered stakeholder centric goals of the change. Indicators will need to be defined to measure the level of achievement of these direct outcomes for impacted stakeholders similar to indicators that measure achievement of strategic goals. This leads to the final general competency question describing why change:

- What are the indicators that measure the level of achievement of direct outcomes for stakeholders?

Understanding the macro, meso and micro "why" behind the change is critical to a more complete definition of the minimum "what" to change to successfully implement the change strategy. In summary, the following set of general competency questions describe the "why" of organizational change at the macro, meso and micro levels.

1. What are the external opportunities to deliver more value to external or internal stakeholders?
    a. Who are the external and internal stakeholders (groups and individuals) who would benefit from the change?
    b. What are the direct outcomes of the change for these beneficiary stakeholders?

c. What value do stakeholder perceive they will receive from achievement of these outcomes?

d. What concerns do stakeholders have about anything that might reduce the value of the change?

2. What are the external threats or internal weaknesses that might increase costs, reduce revenue or market share or reduce current stakeholder value?
3. What are the strategic goals for the organization in response to the opportunities and/or threats and weaknesses?
    a. What are the operational goals that enable achievement of the strategic goals?
4. What are the indicators that reflect and measure the achievement of goals and outcomes (ACMP, 2014)?

2.3.2 General Scenarios for "What to Change?"

A second set of competency questions is needed to bound the scope of the change. The first competency question in this set identifies the key structural outputs of the change (Burke, 2017).

1. What is the resulting output of the change initiative in terms of offerings and/or organization capabilities?

The subsequent set of competency questions bound the scope of change by identifying what aspects of the organization are changing to deliver the change output. In their change-based organization framework, Dunnette and Hough (1992) divide the organization into two sections, the work setting and members. Burke (2017) suggests using an organization model to help categorize the work setting components that are changing but does not define such an organization model. Weisbord's (1976) organization model provides a basic framework for defining a set of competency questions that describe what aspects of the organization capabilities

and structure are changing. Osterwalder's (2004) business model ontology augments Weisbord's model with concepts to address changes in offerings to customers.

2. What, if any, offerings are being transformed or newly established?
3. What business activities involved in delivering the offerings or providing back-office support are changing or being established?
4. What resources (people, process, communication channels, technology, information, policies, etc.) used by these business activities are affected?
5. What functional structures (financial, governance and management) are changing?
6. What incentive or reward mechanisms are changing?

Dunnette and Hough (1992) identify on the job behaviour as the key component of individual change. On the job behaviour can be considered a reflection of cultural change and practice change. Schein and Schein (2016) suggest the desired results of culture change be defined in terms of behaviour. Change in the practise of interacting with customers and with other stakeholders across functional silos is also critical to the organizational change necessary to implement digital services (Ross et al., 2019). This provides the basis for the final competency question to bound change scope.

7. What behaviours of organization members are changing or being established?

The concepts defined below address all the above questions except questions 5 and 6 in keeping with our intent to constrain the focus of this first iteration of the domain ontology as explained earlier in this chapter.

2.4 Concept Descriptions

Since the prime purpose of this ontology is to facilitate communication amongst people, the ontology is defined to the second formality level of a semi-formal expression in a natural language (Uschold, 1996). This means that each concept description contains the concept label, a concise concept definition, identification of its relationships with other concepts and a brief explanation of the concept and its relationships. The modality and cardinality of each relationship is expressed from the direction of the concept being described. For example, Change Driver *influences* Goal (1..n) means that a change driver should influence at least one goal (modality is 1) and a change driver may influence multiple goals (cardinality is n). In the reverse direction Goal *influenced by* Change Driver (0..n) means a goal does not need to be influenced by any change drivers (modality is 0) and a goal could be influenced by many change drivers (cardinality is n).

Where a concept has already been defined in an existing formal or semi-formal domain ontology, we adhere to the existing ontological definition. This is for two reasons. The first reason is to build on the extensive concept definition analysis already performed by the ontology author(s). The second reason is to enable interoperability with existing ontologies as much as possible. Where the same concept was defined differently across ontologies, we build on the definition most aligned with the intent of the relevant competency question. Where the concept does not exist in the reviewed ontologies, we reviewed management literature in search of definitions. These initial definitions were then assembled and refined to align with the intention of the relevant general competency question.

2.4.1 Concepts for "Why Change" Scenarios

The concepts responding to the "why change" general competency questions identify the pertinent change driving forces, macro, meso and micro stakeholder perceptions, and the organization's determined goals in implementing change (Burke, 2017; Diamond, 1992). The concepts identified from the "why change" competency questions are summarized in Table 1. Each concept is then described in further detail below.

Table 1 – Summary of Concepts for Why Change

Competency Question	**Concept**
1. What are the external opportunities to deliver more value to external or internal stakeholders?	Change Driver
a. Who are the external and internal stakeholders (groups and individuals) who would benefit from the change?	Stakeholder
b. What are the direct outcomes of the change for these beneficiary stakeholders?	Goal: Outcome
c. What value do stakeholder perceive they will receive from achievement of these outcomes?	Value Perception: Need Perception: Expectation
d. What concerns do stakeholders have about anything that might reduce the value of the change?	Perception: Challenge Perception: Concern
2. What are the external threats or internal weaknesses that might increase costs, reduce revenue, or market share or reduce current stakeholder value?	Change Driver
3. What are the strategic goals for the organization in response to the opportunities and/or threats and weaknesses?	Goal
a. What are the operational goals that enable achievement of the strategic goals?	Goal: Performance
4. What are the indicators that reflect and measure the achievement of goals and outcomes (ACMP, 2014)?	Indicator

Concept	CHANGE DRIVER
Definition	Exploitable set of external circumstances or internal factors that may provide advantage to an organization in accomplishing its mission or may threaten its survival.
Relationships	*Influences* GOALS (1..n)
References	(Bell & Rochford, 2016; Burke, 2017)

Change drivers are perceived as opportunities or challenges by organization leaders. Opportunities may emerge due to shifts in the organization's environment (Burke, 2017). For example, the availability of new technology may create the opportunity to provide new or enhanced value to customers. Challenges may arise from events or changing circumstances or from internal performance or resource issues (Burke, 2017). For example, new or modified regulation may be viewed as a challenge that drives organizational change to reduce the risk of non-compliance (Tushman & O'Reilly, 1996). In each case the situation must be exploitable by the organization to be considered as a driver for change (Bell & Rochford, 2016).

Concept	STAKEHOLDER
Definition	An organization, group or individual affected by the change.
Relationships	*Ascribes* VALUE (1..n) *Holds* PERCEPTION (1..n) *Provides* RESOURCES (0..n)
References	(ACMP, 2014; Burke, 2017)

Stakeholders affected by organizational change can be categorized based on their relationship with the organization and may be individuals, groups internal to the organization, other organizations, or external groups, e.g. client, employee, partner, supplier, (Frow & Payne,

2011). All stakeholders affected by the change ascribe some level of positive, neutral, or negative value to the change. All affected stakeholders hold perceptions that influence how they make sense of the change and how they determine to engage in the change. Any stakeholder, including customers, may be but are not required to be involved in implementing the change through providing resources to the changing business activity. For example, a client may need to provide a certain technology to access a new integrated service and thus the acquisition of this technology by the client may need to be considered in the scope of the change.

Concept	VALUE
Definition	The importance, worth, or usefulness given by someone to something in a particular context.
Relationships	*Ascribed By* STAKEHOLDER (1..n) *Influenced By* OUTCOME (0..n) *Influenced By* PERCEPTION (1..n) *Delivered By* OFFERING (0..n) *Delivered By* BUSINESS ACTIVITY (0..n)
References	(Jones et al., 2008; Sales et al., 2017)

The value of the change is subjectively ascribed by a stakeholder within a particular context (Jones et al., 2008). Different stakeholders may ascribe different value or different levels of value to the same change (Frow & Payne, 2011). For example, an internal stakeholder may ascribe great value to a change in role, whereas another stakeholder with different skills and aspirations may feel ambivalent or threatened by the change in role and so ascribe no or negative value to the change (Jones et al., 2008).

Ascribed value is temporal and may exist in different states, such as desired and experienced. Desired value is defined during the scoping of change. Experienced value is influenced by the actual organizational change outcomes after the change has been implemented. Stakeholders may also ascribe value to some aspect of the change that is a by-product of the design or the change preparation process, and not directly related to the planned output or outcomes of the change. In the value ascription ontology (Sales et al., 2017) ascribed value is assembled from multiple discrete, but related, components. The detailed concepts of Sales et al.'s (2017) value ascription ontology could be incorporated as needed, depending on the complexity of the organizational change.

Concept	PERCEPTION
Definition	The way in which something related to the change is regarded, understood, or interpreted.
Relationships	*Held By* STAKEHOLDER (1..n) *Influences* VALUE (0..n) *Influences* CHANGE DESIGN REQUIREMENTS (0..n) *Influences* CHANGE RISK (0..n)
References	(Jones et al., 2008)

Stakeholders hold perceptions about their current situation, their desired situation (Sales et al., 2017) and the impact of the organizational change (Burke, 2017; Jones et al., 2008) Employee perceptions of organizational change: impact of hierarchical level} that motivate or demotivate their desire for change. Any of these perceptions may positively or negatively influence a stakeholder's ascribed value of the change. Motivational perceptions can be grouped into four categories: need, challenge, expectation, and concern. Organizational change provides ascribed value to stakeholders when it addresses an unmet need or a current challenge. Value

may be increased when the change also meets stakeholder expectations. Initial identification of stakeholder adoption risk may be derived from stakeholder concerns. Change risk may also occur if the change output does not respond to stakeholders' perceived needs, challenges, or expectations (Jones et al., 2008). Stakeholder perceptions may also influence the change design to ensure delivery of ascribed value. Given the somewhat arbitrary nature of these four classifications of stakeholder perceptions, these four categories received focused reflection and refinement during the third organization intervention.

Concept	GOAL
Definition	Declarative statement of intent to achieve a desired state of affairs.
Relationships	*Influences* VALUE (1..n) *Influenced By* CHANGE DRIVER (0..n) *Influenced By* PERCEPTION (0..n) *Measured By* INDICATOR (1..n) *Enabled By* CHANGE OUTPUT (1..n) *Mitigates* CHANGE RISK (0..n)
References	(Maté et al., 2016a, 2016b; Negri et al., 2017)

Goals can be defined in tiered levels of granularity from strategic to tactical. There are also multiple types of goals. Elaborate ontologies have been defined around the concept of goal (Maté et al., 2016a, 2016b; Negri et al., 2017; Ross et al., 2019). Three broad types of goals are pertinent to defining the scope of organizational change. Each of these types of goals share the same relationships and are therefore grouped together under this definition of goal.

Outcomes are "the consequences of change on the organization" (Al-Haddad & Kotnour, 2015, p.250). When defined as a change goal, an outcome is a specific, measurable result or

effect of a changed action or situation (ACMP, 2014). Outcome management has become a world-wide phenomenon in health care (Miller et al., 2005) and the focus on outcomes is growing in the field of performance management in the public sector (Heinrich, 2002). A focus on outcomes is considered key for successful strategic change execution in any organization (ACMP, 2014; Kaplan, 2011; Maté et al., 2016b). Understanding the intended outcomes of the change at the macro, meso and micro levels is critical for effective adoption of change by internal stakeholders (Balogun & Johnson, 2005; Daly, 1995).

Performance goals are the desired state of execution of an activity. Performance goals are defined for business activities in support of change outcomes.

The goal-oriented requirements ontology (Negri et al., 2017) builds on the work of Zave and Jackson (1997) to define a solution design requirement as a goal. Articulating change design requirements as goals enables a clear distinction between requirement and specification (Negri et al., 2017). This can counter the tendency of stakeholders to define design requirements in terms of predetermined change outputs or features. Design requirements may be targeted at, and thus influence, any component included in the change output. Design requirements may also be identified as critical to mitigating change adoption risk.

Concept	INDICATOR
Definition	A measure of the satisfaction of goals.
Relationships	*Measures* GOAL (1..1) *Influenced by* BUSINESS ACTIVITY (0-n)
References	(Maté et al., 2016b)

Indicators provide the measures that enable assessment of goal achievement. Indicators have clearly defined thresholds and values. The value of an indicator is influenced by the performance of business activities and associated resources.

Concept	CHANGE RISK
Definition	Anything that may hinder successful implementation of the change.
Relationships	*Influences* VALUE (0..n) *Influenced By* PERCEPTION (1..n) *Mitigated By* CHANGE DESIGN REQUIREMENTS (0..n)
References	(ACMP, 2014)

Change risk includes stakeholder change adoption risks, along with standard project management risks (Vrhovec et al., 2015). Stakeholder adoption risks include anything that may reduce the ascribed value of the change for stakeholders, increase the stakeholders' perceived cost or hinder stakeholders from being, or perceiving they are, adequately prepared to implement the change (ACMP, 2014; Vrhovec et al., 2015). Change adoption risk is considered a motivating factor and therefore many influence the value for some aspect of the change when that aspect is primarily included in scope to mitigate the risk.

2.4.2 Concepts for "What Changes" Scenarios

The concepts responding to the "what changes" general competency questions identify any of the organization's operational structures and/or outputs where changes are needed to achieve the desired outcomes. The concepts identified from the "what changes" competency questions are summarized in Table 2. Each concept is then described in further detail below.

Table 2 – Summary of Concepts for What Changes

Competency Question	**Concept**
1. What is the resulting output of the change initiative in terms of offerings and/or organization capabilities?	Change Output
2. What, if any, offerings are being transformed or newly established?	Offering: Product Offering: Service
3. What business activities involved in delivering the offerings or providing back-office support are changing or being established?	Business Activity
4. What resources (people, process, communication channels, technology, information, policies, etc.) used by these business activities are affected?	Role Organization Unit Process Guide Technology Information Infrastructure Channel
5. What functional structures (financial, governance and management) are changing?	Out of scope for this initial draft
6. What incentive or reward mechanisms are changing?	Out of scope for this initial draft
7. What behaviours of organization members are changing or being established?	Behaviour

Concept	CHANGE OUTPUT
Definition	The collection of various operational organizational aspects that are changing or being newly established to achieve the change outcomes.
Relationships	*Includes* OFFERINGS (0..n) *Includes* BUSINESS ACTIVITIES (1..n) *Includes* BEHAVIOUR (0..n) *Includes* RESOURCES (0..n)
References	(Burke, 2017)

Change output describes the scope of offerings, business activities, behaviours, and/or resources undergoing modification or creation to achieve the organization's goals and deliver ascribed value to stakeholders.

Concept	OFFERING
Definition	A set of products and/or services, together with a mechanism of provision that provides value to the customer or client.
Relationships	*Part of* CHANGE OUTPUT (0..1) *Provided By* BUSINESS ACTIVITY (1..n)
References	(Johnson et al., 2008; Osterwalder, 2004)

Offerings generally consist of a combination of products and/or services. Offerings are considered within the scope of organizational change only if changes to these offerings involve change in the provisioning business activities. Organizational change does not necessarily involve offering change. For example, change to back office processes and technology will impact business activities but might not impact any offerings.

Concept	BUSINESS ACTIVITY
Definition	"The engagement of human, physical and/or capital resources of any party to the business model (the focal firm, end customers, vendors, etc.) to serve a specific purpose toward the fulfillment of the overall objective."
Relationships	*Part of* CHANGE OUTPUT (1..1) *Provisions* OFFERING (0..n) *Delivers* VALUE (0..n) *Enables* GOAL (1..n) *Influences* INDICATOR (1..n) *Requires* RESOURCES (1..n) *Influenced By* BEHAVIOUR (0..n) *Supports* BUSINESS ACTIVITY (0..n)
References	(Zott & Amit, 2010, p.217)

In practice, depending on the business architectural lens, a business activity may be a top-level business process or the implementation of a business capability. Business activities may be hierarchically defined. They may directly provision offerings, or they may support other business activities and deliver ascribed value to internal stakeholders. Business activities require a coordinated set of resources to fulfil their purpose and enable the achievement of organization goals. The effectiveness and performance of business activities may also be influenced by stakeholder behaviour. Business activities enable goal indicators to be tracked and thus influence the attributes and results of these indicators.

Concept	BEHAVIOUR
Definition	The way in which a person conducts herself/himself in fulfilling a role in the organization.

Relationships	*Part of* CHANGE OUTPUT (1..n) *Enacted By* STAKEHOLDER (1..n) *Influences* BUSINESS ACTIVITY (1..n) *Required By* ROLE (0..n)
References	(Campbell et al., 1990; Hunt, 1996)

The gap between required behaviour and actual behaviour of anyone involved in the execution of a business activity can impact the performance and effectiveness of the business activity (Campbell et al., 1990; Kristof, 1996). Thus, changes in any part of a business activity may require changing the types of behaviours needed. There are multiple dimensions of behaviour defined by various models (Hunt, 1996), but modeling the concept of behaviour to greater levels of detail is left for future work. The objective of including behaviour in this initial ontology is simply to enable early identification of behaviour changes that are critical to the success of the change.

Concept	RESOURCE
Definition	Any asset or expertise required to accomplish an activity.
Relationships	Part of CHANGE OUTPUT (1..n) *Required By* BUSINESS ACTIVITY (1..n) *Provided By* STAKEHOLDER (0..n) *Requires* RESOURCE (0..n)
References	(Grant, 1991; Guizzardi et al., 2008)

The concept of resource is included in this ontology as an aggregation of the different types of organizational resources utilized by a business activity. This is primarily to reduce the complexity of relationships in the meta model and to reduce the duplication of attributes in the

concept definitions. Any concept defined below as a type of resource inherits the relationships defined here for Resource. Resources are provided by stakeholders (Frow & Payne, 2011). Any resource may require other resources to function. There are many types of tangible, intangible and expertise-based resources (Grant, 1991). Some general types of resources that are most pertinent to defining the scope of change are described below. For each resource type, only relationships that are additional to those defined in the above table are identified.

2.4.2.1 Resource Sub-Types

Concept	BUSINESS PROCESS
Definition	Structured work performed to achieve the organization's goals and deliver value to stakeholders.
Relationships	*Flows To* PROCESS (0..n) *Defines* ROLE(1..n)
References	(Burlton, 2012)

Business processes can be hierarchically defined and can flow sequentially or dynamically from one to another.

Concept	ROLE
Definition	The function assumed by a stakeholder in a process or particular situation.
Relationships	*Fulfilled by* STAKEHOLDER (1..n) *Requires* BEHAVIOUR (0..n) *Relates To* ROLE(1..n) *Defined By* PROCESS (0..n) *Defined By* ORGANIZATION UNIT (0..n)
References	(Guizzardi & Wagner, 2004)

Roles can be fulfilled by an external stakeholder (e.g. customer) or an internal stakeholder. Roles are defined in the context of a process or within an organization unit. Certain behaviours may be required to be enacted for effective execution of the role. Roles relate to other roles either structurally through organization units or dynamically through processes.

Concept	ORGANIZATION UNIT
Definition	A defined group of responsibilities for accomplishing a specific purpose.
Relationships	*Defines* ROLE (1..n)
References	(Guizzardi & Wagner, 2004)

Organizations can be structured in various ways from hierarchies to adhocracies (McKenna & Wright, 1992), therefore a very flexible definition of organization unit is required for this domain ontology. An organization unit may be hierarchically contained within another organization unit with the whole organization as the top unit. Organization units can also be temporal and cross-functional such as project teams and communities of practise and may include external stakeholders.

Concept	CHANNEL
Definition	A mechanism for interaction between an organization and its stakeholders.
Relationships	No additional relationships other than those defined for RESOURCE
References	(ACMP, 2014; Osterwalder, 2004)

A channel is primarily used to describe how an organization reaches it customers and clients (Osterwalder, 2004). A channel also describes the mechanism used by stakeholders to share information formally and informally (ACMP, 2014).

Concept	TECHNOLOGY
Definition	The application of scientific knowledge for practical purposes, especially in industry.
Relationships	*Provisions* Information (0..n)
References	(Oxford English Dictionary, 2018)

Technology encompasses all degrees of complexity in electronic, mechanical, or other types of systems. Technology can be complex information systems or artificially intelligent equipment, networked intelligent devices or single purpose sensors. Technology can also be simple physical devices such as a paper file storage and retrieval system. Technology often generates, stores and/or provides access to information.

Concept	INFRASTRUCTURE
Definition	The basic organizational structures and facilities needed for the operation of a society or enterprise.
Relationships	Inherits from RESOURCE
References	(Oxford English Dictionary, 2018)

Infrastructure is an aggregate concept to describe physical, virtual, or ubiquitous assemblages of assets. Infrastructure may be physical, such as roads or buildings. Infrastructure may be virtual, such as brand or intellectual property. Infrastructure may also be a managed set of technology. For example, network routers are technology, but the electronic network as a whole, is the infrastructure that enables electronic information flow.

Concept	GUIDE
Definition	Static definition that steers or controls the business activity of an organization.
Relationships	*Influences* RESOURCES (0..n)
References	(Brocke et al., 2010)

Guides generally include laws, regulations, industry standards, best practices, internal policies, and business rules (Brocke et al., 2010). Guides are defined and repeatedly applied to purposely influence the way work is performed or the decisions made. Guides are not events or circumstances.

2.5 Conclusion

This chapter presented an initial definition of a cohesive domain ontology to provide a common terminology for articulating the scope of organizational change. The ontology content was constrained to the concepts necessary to understand desired organizational change to service delivery. The concepts included in the ontology were integrated from different streams of management research with complementary foci on various aspects of strategic change.

This domain ontology highlights the linkages between stakeholder value and change output that underpin successful change adoption. It extends the goal-oriented ontology model to the articulation of change design requirements as goals, thus promoting the focus of the change scope to be on value creation rather than on solution specification. This extension undergirds the growing emphasis on outcome management and benefits realization frameworks in ensuring successful organizational change. This domain ontology makes a small and cursory attempt at scoping organizational culture change by introducing the concept of human behaviour necessary to effectively perform a role. Finally, this ontology identifies the links between change risk and

stakeholder perceptions, along with the potential mitigating effects of change design requirements. Figure 3 depicts a visual representation of the meta-model for the ontology, identifying the concepts and their relationships.

The purpose of this domain ontology is to provide a semantic foundation for developing an intuitive visual language for modeling organizational change. The ontology is not meant to be an exhaustive definition of all aspects of organizational change. The scope of the ontology is limited to the concepts relevant to enable stakeholder comprehension of organizational change to service delivery. With the knowledge vocabulary defined, the next step in developing the visual language was to define the conceptual modeling grammar. This is described in the following chapter.

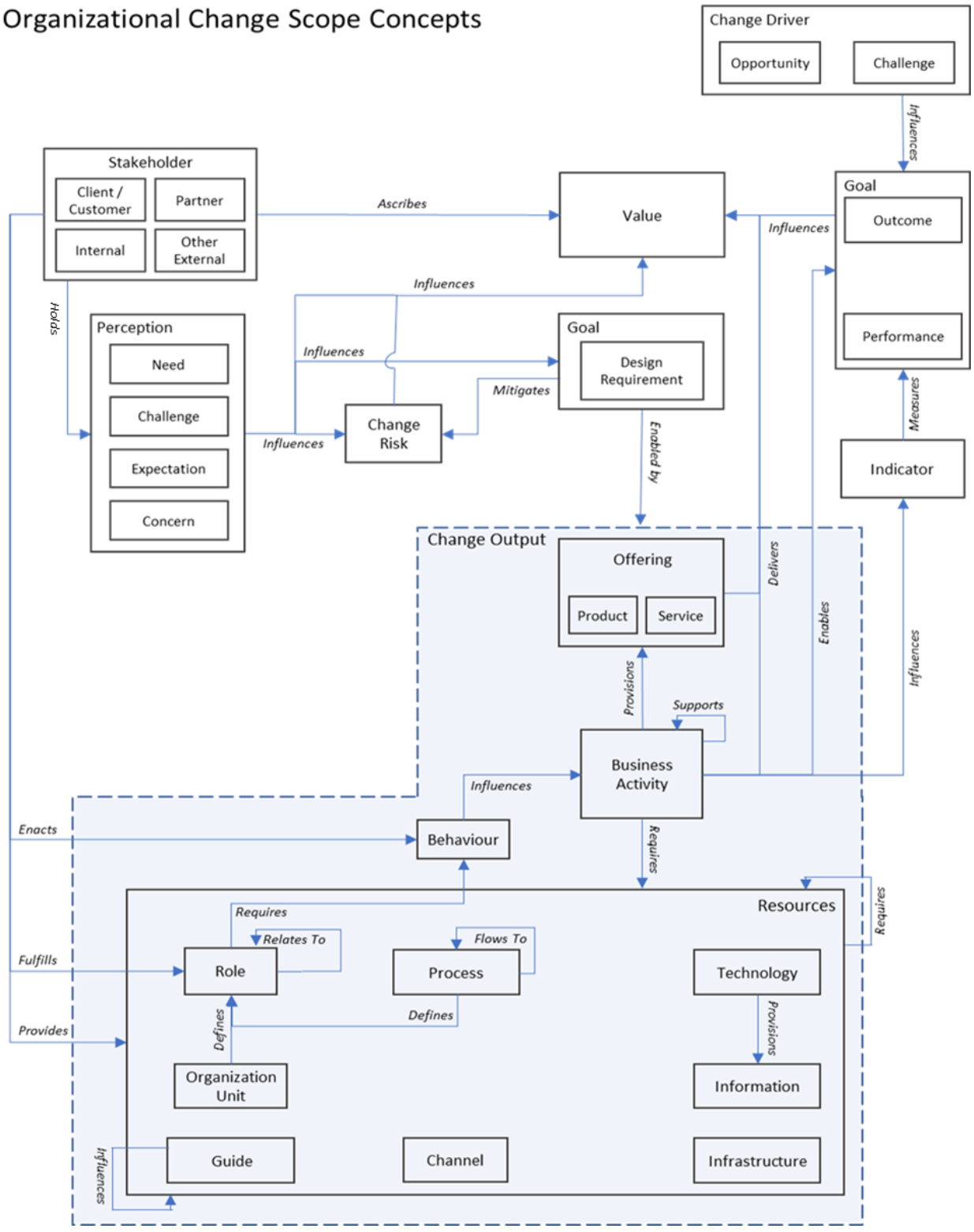


Figure 3- Organizational Change Scope Meta-Model

3 VISUALLY DEPICTING THE SCOPE OF ORGANIZATIONAL CHANGE – A THEORY BASED DESIGN OF A CONCEPTUAL MODELING GRAMMAR AND MODELING METHODS

3.1 The Purpose of a Conceptual Modeling Grammar

The scope of organizational change is complex. The organizational change domain ontology described in the previous chapter contains numerous concepts and relationships among them. When scoping organizational change, each of these concepts will have multiple instantiations. This high volume of complex information creates a significant cognitive load for individuals seeking to understand the necessary scope of the change. Cognitive research has demonstrated the human brain is able to process graphical information more rapidly than textual information (Bauer & Johnson-Laird, 1993; Belova, 2006; Borghesani et al., 2016; Larkin & Simon, 1987). In addition, visual neurological processes in the brain enable more efficient recognition of complex patterns and relationships than do the neurological processes for comprehending spoken and written speech (Dansereau & Simpson, 2009; Larkin & Simon, 1987). One reason for these abilities is that graphical representations can act as external working memory. This reduces the cognitive load of reading a sequential description and trying to construct and keep a mental image of all the components in the description and their relationships (Bauer & Johnson-Laird, 1993, 2016; Larkin & Simon, 1987). In addition, since a graphical representation can be read as a whole, it contributes to holistic rather than compartmentalized understanding of a situation (Lindquist, 2011).

A graphical representation of a conceptual model meant to facilitate communication of complex patterns of reality for a specific purpose can be constructed as a diagram (Evermann &

Wand, 2005). Effective diagrams highlight important information represented by symbols and the spatial relations of the symbols. To be most effective in conveying complex patterns, the contents (semantics) and form (graphical representation) of a diagram needs to be aligned with the neurological processes in the human brain (Figl et al., 2013; Moody, 2009). Shannon and Weaver's (1963) communication theory is widely used to understand how communication happens and is understood. Their theory can be applied to using diagrams as a form of communication (Moody, 2009).

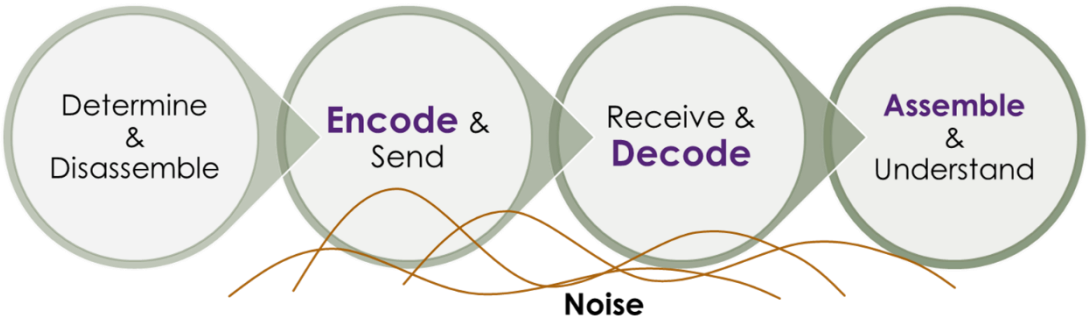


Figure 4- Information Transmission Process Adapted from Shannon and Weaver (1963)

The visual representation of a conceptual model is the signal that is disassembled and encoded by the information sender and decoded and assembled by the information receiver (Figure 4). Information loss and misunderstanding occur when the sender and the receiver do not use the same code for the coding and decoding process. For example, a yellow traffic light is a common visual symbol but there are different codes used for this symbol in different countries. In England, a yellow traffic light means get ready to go. In North America, a yellow traffic light means get ready to stop. If North Americans driving in England use the North American code to interpret the yellow traffic light symbol in England, they will misinterpret the meaning of the symbol. An explicitly defined conceptual modeling grammar provides the code to encode and

decode a diagram and achieve a common understanding. A conceptual modeling grammar consists of a set of visual semantic constructs identified by symbols (notation) and rules to combine these constructs (Wand & Weber, 2002).

Even when a common code is used by the sender and receiver, random variation in the signal creates noise that can distract from or distort the intended message (Moody et al., 2010). Noise can be caused by irrelevant or excess conceptual or visual information. Chabris and Kosslyn (2005) argue that the most effective diagrams depict information in a way that is more closely aligned to our internal mental representations. Therefore, to promote effective communication, the conceptual modeling grammar used to encode/decode the diagram needs to be aligned with the domain ontology used to define the mental concepts being communicated. In addition, the grammar and the ontology need to be constrained to the purpose of representing just the necessary elements of the topic at hand (Moody, 2009).

The two challenges driving the need for a more effective and efficient means of communication with stakeholders engaged in scoping organizational change, that we sought to address in this research are scarcity of time and mental energy. To adequately address these challenges, two design goals were defined for the proposed conceptual modeling grammar. These design goals provided the reference points for evaluating the utility and efficacy of the visual language. First, the visual language must be quick and easy to learn (Petrusel et al., 2017). When stakeholders are initially presented with communication using this visual language, it is imperative that they perceive this to be an intuitive and easily understood medium. Second, critical information relevant to certain stakeholders must be readily apparent. It must be easy for them to focus on the relevant information without needing to sift through less relevant information or be distracted by visual noise (Mayer & Moreno, 2003). We wanted to avoid the

first perception of stakeholders being that this communication will take more time and effort to understand than they currently have available. When busy stakeholders experience this negative perception, they may, in the words of one physician who participated in this research, “put it aside to read later and then never get to it.”

Sweller and Chandler’s (1991) concept of cognitive load provides a helpful description of the different levels of mental effort required to understand something. To achieve the two goals described above, the stakeholders must perceive the overall mental effort of reading and understanding a diagram to be low. There are three types of cognitive load: intrinsic, extraneous, and germane (Sweller & Chandler, 1991). Intrinsic load is defined by the complexity of the information. Extraneous load is caused by the way in which the information is communicated. Germane cognitive load is incurred due to the cognitive process and resources used for learning and understanding. Reducing intrinsic and extraneous cognitive loads allows the human brain to devote more resources to germane cognition, which increases the efficiency of the expended mental effort and reduces the overall perceived cognitive load.

The greater the number of concepts and relations between concepts, the higher the intrinsic cognitive load. Although the number of concepts and relationships defined in the conceptual model in Chapter 2 is high, an excessive level of intrinsic load is avoided when there is a precise mapping of ontological concepts to the corresponding visual semantic constructs in the grammar. Moody (2009) recommends a one to one mapping of ontological concepts to visual semantic constructs (Figure 5). This maximizes consistency between the coded representation mapping (the intended meaning) and the decoded interpretation mapping (what is understood). A one to one mapping eliminates the ambiguity that can be caused by construct redundancy (one ontological construct to many grammatical constructs) and construct overload (many ontological

constructs to one grammatical construct). A one to one mapping also eliminates construct deficit (missing visual semantic constructs) and construct excess (visual semantic constructs with no useful meaning relevant to the modeled domain) (Wand & Weber, 2002).

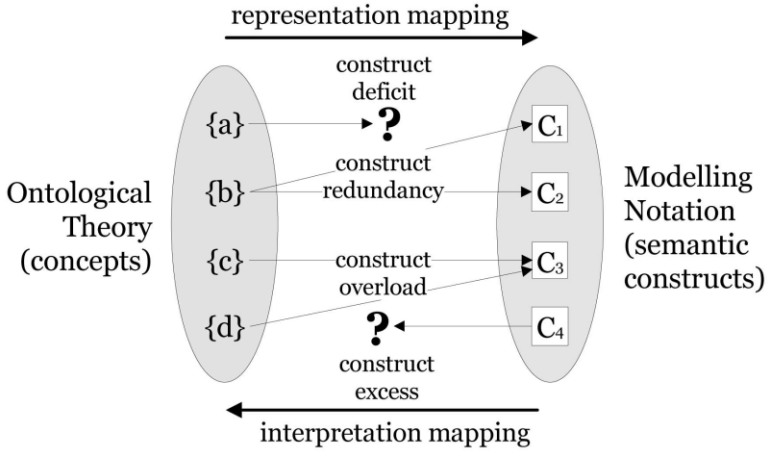


Figure 5 - Ontological Analysis of Concept to Visual Construct Mapping (Moody 2009 p.759 adapted from Wand and Weber 2002)

Extraneous cognitive load is affected by the way information is represented. This includes the design of the visual semantic constructs and their layout in the diagram. More complex and less intuitive visual constructs increase extraneous cognitive load. In addition, the layout of the visual representation and the presence of non-meaningful graphics impacts extraneous cognitive load.

Figl et al., (2013) demonstrated that various characteristics of symbol sets influenced cognitive load and model comprehension. The visual variables used for encoding symbols can be categorized into two types (Bertin, 1983). Planar variables describe the spatial characteristics of vertical and horizontal spacing. Retinal variables describe the features of the retinal image including shape, size, colour, brightness, orientation, and texture. These variables can be

combined in multiple ways to construct symbols which have certain semantic meaning and thus can convey information.

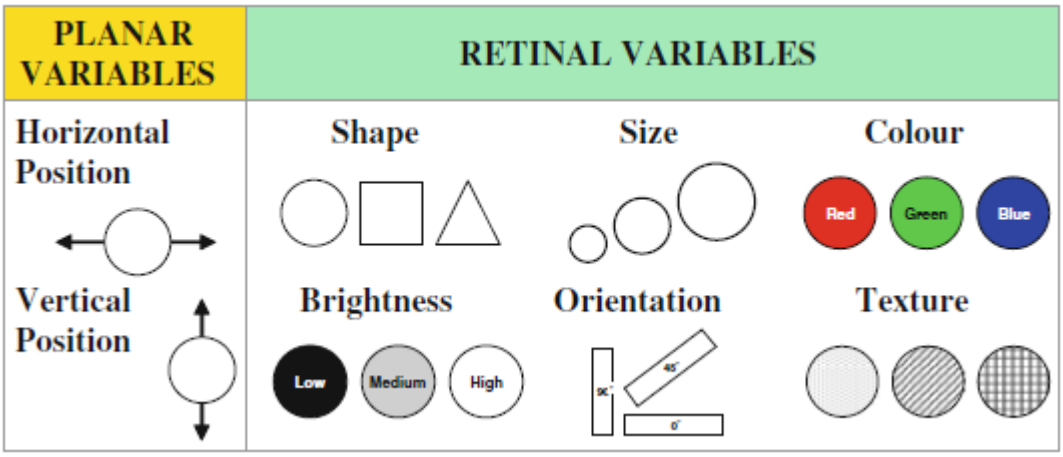


Figure 6- Visual variables from Moody et al. (2010 p. 140) adapted from Bertin (1983)

Effective diagrams highlight important information represented not only by symbols, but also by their spatial relations. Effective diagrams also enable the reader to focus on pertinent information and ignore irrelevant detail. Thus, to ensure consistent coding and decoding, rules for the design, scope, and layout of different types of diagrams must be explicitly defined. This set of rules or guidelines is documented as a conceptual modeling method, which describes the procedures by which a conceptual modeling grammar can be used (Wand & Weber, 2002).

3.2 Theoretical Guidelines for Visual Semantic Constructs

Until recently there has not been a set of theoretically based principles for developing visual semantic constructs. Most IS modeling grammars with a formal notation have been developed by trial and error and/or based on practical experience (Moody, 2009). In 2009, Moody published *The "Physics" of Notations (PoN)* outlining nine guidelines for effective notations. These guidelines are based on a combination of empirically tested theories from various fields including "theories from communication, semiotics, graphic design, visual

perception and cognition" (p.760). The PoN has been used to evaluate the visual notation of various existing modeling grammars (Genon et al., 2010; Moody et al., 2010; Popescu & Wegmann, 2014; Störrle & Fish, 2013a). Although the PoN guidelines are not yet at a stage to enable a falsifiable assessment of a modeling grammar (Störrle & Fish, 2013b), they do provide a theoretical framework for considering cognitive effectiveness during development.

Moody's nine PoN guidelines plus an additional guideline are described below along with specific considerations relevant to the purpose of the proposed modeling grammar.

PoN Guideline	**Semiotic Clarity**
Description	"There should be a 1:1 correspondence between semantic constructs and graphical symbols" (Moody, 2009, p.762).
Specific Considerations	To reduce training requirements, it may be advantageous to relax this principle and allow symbol deficit. Since textual notations require no training, it may be expedient in certain cases to use a text notation rather than a symbol (Ottensooer et al. 2012).

PoN Guideline	**Perceptual Discriminability**
Description	"Different symbols should be clearly distinguishable from each other" (Moody, 2009, p.763– 64). For example, a square and a triangle are clearly distinguishable shapes as there is a 25% difference in the number of sides and a 50% difference in the amount of occupied space. But a heptagon and an octagon are difficult to distinguish because the number of sides and occupied space are similar.
Specific Considerations	Attention should be given to redundant variable coding (using more than one visual variable to encode a symbol) to increase the visual differentiation cues between symbols. For example, when shapes that are similar, such as variations of the corner shapes on a rectangle, perceptual discriminability of the symbols can be increased using colour as a second

	coding element. When using colour as a distinguishing factor it is important to use contrasting colours and potentially contrasting brightness to ensure people with colour blindness are still able to easily distinguish the symbols.

PoN Guideline	**Semantic Transparency**
Description	"Use visual representations whose appearance suggests their meaning" (Moody, 2009, p.764–766). For example, use of arrows is intuitive for representing sequence or causality but not for representing other types of relationships.
Specific Considerations	In developing this grammar, consideration was given to the use of space and physical layout to represent relationships rather than arrows. Attention should be given to use of icons. When icons are universally intuitive and appealing, this can decrease time and effort to learn the modeling grammar. However, icons that are not universally intuitive can easily be misinterpreted and cause confusion.

PoN Guideline	**Complexity Management**
Description	"Include explicit mechanisms for dealing with complexity" (Moody, 2009, p.766-767).
Specific Considerations	This is a critical guideline for our modeling grammar. Complex diagrams increase the cognitive load for identifying critical relevant information. A hierarchical or modular set of diagrams following a similar layout may be less daunting and more inviting. As much as possible users should perceive that the diagram can be easily understood.

PoN Guideline	Cognitive Integration
Description	"Include explicit mechanisms to support integration of information from different diagrams" (Moody, 2009, p.768). This includes both conceptual mechanisms and perceptual cues that enable users to easily navigate back and forth between diagrams.
Specific Considerations	When generating a new diagram to further decompose a visual semantic construct on another diagram, consider using the visual construct's symbol and label for the title of the linked diagram. For example, use the business capability symbol and instance label as the title of the change scope diagram for that individual business capability.

PoN Guideline	Visual Expressiveness
Description	"Use the full range and capacities of visual variables" (Moody, 2009, p. 769).
Specific Considerations	In the context of scoping organizational change, visual expressiveness needs to be tempered with speed of comprehension. Consideration is needed in this area to determine the optimum level of comprehension accuracy verses comprehension speed.

PoN Guideline	Dual Coding
Description	"Use text to complement graphics" (Moody, 2009, p,771).
Specific Considerations	Consideration should also be given to using both text and symbols where this would improve the speed of comprehension without adding cognitive load in identifying relevant information. Annotations can also be used to speed up comprehension for those unfamiliar with the grammar. Consider using a grey colour for annotations to reduce visual distraction.

PoN Guideline	Graphic Economy
Description	"The number of different graphical symbols should be cognitively manageable" (Moody, 2009, p.771-772).
Specific Considerations	This is a critical principle given the need for minimal training and minimal cognitive load. Moody notes that empirical studies show novices are particularly adversely affected by graphical complexity in terms of ease of understanding.

PoN Guideline	Cognitive Fit
Description	"Use different visual dialects for different tasks and audiences" (Moody, 2009, p.772-773).
Specific Considerations	This is a critical principle given the need for minimal training and minimal cognitive load. Moody notes that empirical studies show novices are particularly adversely affected by graphical complexity in terms of ease of understanding. The prime purpose of this proposed modeling grammar is to facilitate understanding of the scope of change across management and staff. Therefore, one simple dialect should be developed. Furthermore, use of a consistent diagram layout across multiple types of diagrams can reduce cognitive load as the user gains familiarity with the layout. Consideration should be given to limiting the number of different diagram layouts and ensuring that similar layouts represent similar meanings. Another aspect of cognitive fit not mentioned by Moody is style. Black and white diagrams filled with square boxes and lines may appear harsh and technical and therefore perceived as complicated and requiring effort to understand. Coloured diagrams containing shapes with rounded edges and few lines may appear friendlier and therefore perceived as easier to understand (Bar & Neta 2006). First impressions of

	understandability (less expected effort) verses complexity (more expected effort) are critical when attempting to engage busy managers and staff.

New Guideline	**Graphical Flow**
Description	This guideline is not mentioned by Moody but is alluded to by Störrle and Fish (2013). The layout of a diagram guides the flow of reading the diagram. A complex or chaotic flow will increase the amount of time and effort to identify and comprehend relevant information in the diagram.
Specific Considerations	To achieve the two goals specified for this modeling grammar, the graphical flow of the diagrams should be designed with the aim towards simplicity and the ability to quickly locate relevant information.

3.3 Brief Review of Four Types of Popular Modeling Grammars

A cursory review of four popular types of conceptual modeling grammars was performed to assess and learn how these grammars applied the PoN principles and how user comprehension was consequently affected. The review confirmed that these grammars are not ideally suited for communicating scope of service change with managers and staff. However, conceptual modeling grammar features that can be built on or should be considered when developing a new grammar were identified. The review considered the extent to which the concepts defined in Chapter 2 were covered by the grammar, how well the grammars conformed to the PoN principles and the ontological clarity of the grammars. The review started with process modeling languages and data modeling languages in general, along with some evaluation of specific languages where applicable. Unified Modeling Language (UML) was then reviewed as representative of a general-purpose conceptual modeling language. Finally, the Business Model Canvas was

reviewed as it is a popular and relatively recent visual representation with a very narrow purpose focused on defining a business model.

The review of process modeling languages included Business Process Modeling Notation (BPMN), and diagram syntaxes, such as IDEF0 and the IGOE process scope diagram popularized by BPTrends. The primary purpose of process modeling languages is to depict the decomposition and flow of process and activities in an organization (Figl, 2017). Therefore, it is not surprising that none of them accommodated all the concepts defined in Chapter 2. We found they lacked visual semantic constructs for offerings, stakeholder perceptions, ascribed value, goal, and adoption risk. IDEF0 diagrams include the concepts of input, output, control (guide in IGOE), mechanism (enabler in IGOE) and function (process in IGOE). In addition, IGOE diagrams may also include status of an element and status measurement (Harmon, 2012). BPMN includes the concepts of event, activity, decision gate, association, flow, pool, lane, and data object. It does not identify resources types other than data (White, 2004).

IGOE diagrams use dual coding so can be quickly understood with minimal explanation, but users of BPMN, require training before they are comfortable with the grammar (Aagesen & Krogstie, 2010). Neither BPMN nor IDEFO notations fully conformed to the PoN (Genon et al., 2010). However, the lane construct is one feature in BPMN that could be incorporated with some modification in the proposed grammar. A lane visually contains the activities that are the responsibility of its represented role (Aagesen & Krogstie, 2010). A similar horizontal visual construct could be used to depict the various concepts related to a stakeholder, such as benefits, impacted capabilities, or processes. Using a graphical construct like the lane as container to represent relationships with the contained element could support the graphic economy principle and reduce the need for arrows. However, the implementation of the lane construct in BPMN

suffers from construct overload as it is not clearly distinguished from the similar pool construct (Recker et al., 2011). Therefore, we only defined a construct similar to the lane construct and did not include the pool construct.

The primary purpose of entity relationship (ER) modeling languages is to depict the types and relationships of various entities in a domain (Parsons, 2003). At first glance this category of modelling languages is well aligned to the purpose of our proposed modeling grammar. All the identified concepts could easily be represented as one of the three abstract concepts in the ER grammar: entities, attributes of entities or relationships between entities. But the syntax of ER diagrams is too constrained for the purpose of our proposed grammar. All entities are represented by the same graphical symbol, a rectangle. This would result in substantial symbol overload, and thus low semiotic clarity, in representing the concepts defined in our domain ontology (Moody, 2009). There is no facility for the use of icons or other graphically rich syntactical elements.

UML is commonly used in the context of IT application development. The language specification includes diagrams used for the purpose of communication with non-technical business stakeholders and diagrams used for describing technical designs. The diagram types most used for communication with business stakeholders are the use case diagram and the activity diagram (Dobing & Parsons, 2006). Neither the use case nor the activity diagrams include symbols for depicting perceptions, value, goals, and different types of resources. Activity diagrams are like BPMN swim lane diagrams. They consist of horizontal or vertical lanes representing the participants in a set of activities. Each vertical lane contains the activities, represented by ovals, that the participants engage in. Arrows from one activity to another represent the sequential flow of activities. An activity diagram may also contain events and other types of flow control constructs (Fakhroutdinov, 2009). The class diagram is more flexible and

similar to entity relationship diagrams. It could be used to represent all the required concepts and their relationships. However, the class diagram suffers from the same limitations as described above for entity relationship diagrams. Rectangles are used to represent all classes, and lines are used to represent all relationships between classes (Fakhroutdinov, 2009b). Class diagrams have extremely low semiotic clarity and very low semantic transparency (Moody, 2009) and thus would not adequately serve the goal of the proposed grammar to reduce cognitive load.

The business model canvas (BMC) is comprised of a visual representation and a domain specific conceptual model. The purpose of the business model canvas is to "translate a company's strategy into a blueprint of the company's logic of earning money" by describing what value the company offers to which customers and how it offers this value (Osterwalder, 2004 p.14). The key concepts represented by the business model canvas are customer, partner, customer value, business offering, customer relationship, delivery channel, business capability or activity, resource, and financial account. There is considerable overlap between these concepts and the proposed concepts identified in chapter 2. However, the BMC does not contain any concepts related to stakeholder perception and adoption risk, nor to various types of goals.

The visual syntax of the BMC is very lightweight and semiotic clarity is very low. There is no defined symbol set. The different concepts are indicated by their spatial placement within labeled rectangular boxes that have a fixed position in the diagram. There is no visual representation of relations between the concepts. Despite these visual syntax limitations, the BMC visual representation has achieved popularity in the business world as an effective communication tool that is easy to learn (Cosenez, 2017). It does appear to achieve good cognitive fit and graphic economy. Although there are no defined symbols, there is some perceptual discriminability achieved by the boxed layout. Instances of the same concept are

grouped together in a box and each box is labeled to identify the type of concepts it contains. This achieves good perceptual pop out once familiarity of the layout is acquired (Petrusel et al., 2017). The spatial grouping and labeling of the concepts could be a useful feature for a diagram focused on intuitively conveying scope of change.

3.4 Proposed Conceptual Modeling Grammar

The development of the visual semantic constructs in the conceptual modeling grammar started with application of the principle of semiotic clarity (Moody, 2009). A distinct visual semantic construct was created for each concept in the domain ontology defined in Chapter 2. A mixture of basic shapes, such as rectangles and ellipses, and simple icons was chosen to reduce visual complexity and therefore visual cognition processing effort. We then applied the principle of semantic transparency (Moody, 2009) to design the representation of relationships between concepts. We leveraged the spatial syntax of set diagrams to represent the "contains" relationship. In set diagrams, a set is depicted by a circle and subsets contained within that set are depicted as smaller circles located within the circle representing the set. This style of representing the "contains" relationships provides more semantic transparency then lines and appears less technical, potentially providing better cognitive fit for the intended users.

Basic shapes were selected for the concepts that could or would most likely be decomposed into more elements, such as business activity and process. A basic shape was chosen for these so that the symbols for the individual elements could be spatially located inside the symbol of the containing construct to visually represent the "contains" relationship. Basic shapes were also used for concepts for which a universally used icon was not in common use, such as perception and value. Shapes with curves or rounded corners were used to represent concepts that were more subjective and/or generally not precisely defined such as perception,

value, and business activity. We made this design decision because the grammar needed to be as attractive and non-threatening as possible to encourage people to engage with the diagrams. People generally prefer curved shapes over shapes with sharp angles unless the sharp shapes have strong positive associations because sharp angles are subconsciously associated with threat (Bar & Neta, 2016). We were concerned that ambiguous concepts could create a feeling of threat and based on the principle of cognitive fit (Moody, 2009) we want the visual constructs to fit the purpose of the grammar as much as possible. Based on this same principle, shapes with sharp corners were used for concepts that are generally accepted to be more "technical" and precisely defined (Bar & Neta, 2016) such as technology, guide, and process, where representation by rectangles and other sharp shapes was common in business communications such as flow charts.

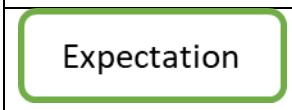
In accordance with the principles of perceptual discriminability and visual expressiveness, each shape was prescribed a distinct colour. Thus, each construct had a unique shape and a unique colour or shade of colour. Sub-types of a concept were identified by different colours, for examples sub-types of perception, and/or variations on the shape, such as sub-types of resource, which had different colours and small variations of the rectangular shape. In line with the principle of semantic transparency simple icons were used where it was deemed plausible to find or create one that would be easily and unambiguously understood.

The selection of shapes and icons for each of the semantic constructs was guided by Moody's principles of semiotic clarity, cognitive fit, perceptual discriminability, visual expressiveness, and semantic transparency. However, Moody's design principles are neither precise enough nor comprehensive enough to evaluate existing notations (Störrle & Fish, 2013b). There are numerous ways of implementing these principles with no precise guidance on which option to choose. This means that the design decisions made following these principles may not

achieve the intended design outcomes in the environment in which the artifact is deployed and thus are subject to design indeterminacy (Lukyanenko & Parsons, 2020). In addition, although we used design theories to guide the definition of the shapes and icons for each construct, many detailed design decisions, such as colour, were made based on common practises. In a few cases, the specific design decision was creative and arbitrary.

The initial set of visual semantic constructs are defined below. The definition includes, the identification of the matching concept, a description of the shape and colour and a justification for these two design choices. The design choices for some of these constructs were subsequently modified during the interventions. These modifications are explained in the subsequent sections that detail the findings of the interventions.

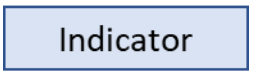
3.4.1 Semantic Construct Definitions

Perception	
A rectangle with rounded corners was chosen for perception and different colours were used to denote different sub-types of perception.	
	Strong yellow was selected as a common colour used for caution or warning or problem.
	Red was selected as a common colour used for stop or high risk.
	Green was selected as a common colour used for growth and go ahead.
	Blue was selected as it was the only other basic colour available.

Value	
	A flattened ellipse was chosen for value. Purple was selected as it has some connotations for royalty and associated high value. It is also a strong colour that is distinguishable from the other colours used for Perception.

Stakeholder	
Not initially defined	A symbol for stakeholder was not defined prior to the interventions. In the first two interventions no symbol was used, and stakeholders were identified only by a textual label. An icon for stakeholder was introduced in the third intervention.

Goal	
	A simple checkmark was chosen to denote any type of goal. This icon was selected to promote positive expectation of achieving the goal. However, this icon was changed during the third intervention.

Indicator	
	A blue shaded rectangle with a dark blue outline was chosen for indicator as indicators are generally precisely (sharp corners) and objectively and intellectually (dark blue) defined.

Change Risk	
Not initially defined	A symbol for risk was not defined prior to the interventions. During one of the interventions we defined in icon for risk.

Offering	
Not initially defined	A symbol for offering was not defined prior to the interventions. Since, the symbol for this concept did not end up being specifically depicted in any of the three interventions, this symbol remained undefined in this research.

Business Activity	
	A tan rectangle with rounded ends and a dark tan outline was chosen for business activity. Tan is a neutral colour and since a business activity will contain other elements a neutral colour is a good choice to enable perceptual discriminability of encompassed symbols of any colour. To increase the perceptual discriminability of this shape from perception (rounded rectangle) and value (flattened ellipse) this shape

	is shaded. Shading also increases perceptual discriminability for those who have colour blindness and cannot easily distinguish purple and dark tan, or green and dark tan. Particular attention was paid to the value and business activity symbols during the intervention. observations and reflections to identify if there were issues with perceptual discriminability.

Behaviour	
Not initially defined	Prior to the interventions a symbol for behaviour was not defined. We did not find a common intuitive icon for behaviour, and we were running out of simple shapes that could accommodate a long label. Participants suggested to use the checkmark icon during the first intervention. However, this icon was the same checkmark icon used for "goal." We resolved this icon duplication in the third intervention by defining a different symbol for goal.

Resource	
Not initially defined	We did not initially define a symbol for resource as the expectation was that the resource subtypes would be used instead. However, in the third intervention, we did use the general resource visual construct and thus defined a symbol.

Process	
	A simple orange chevron shape was selected to represent process. The chevron is often used to represent processes in high level presentations. Orange was selected because it had not been assigned to any other symbol.

Role	
Not initially defined	Prior to the interventions a symbol for role was not defined. Although a business activity role could be considered conceptually different from an internal stakeholder group, a role could also be a greater level of specification or a sub-type of an internal stakeholder group. Defining a symbol for this concept was left until it would be needed in one of the interventions. However, none of the interventions required any specificity beyond stakeholder. Thus, a symbol for this concept was not defined in this research.

Organization Unit	
Not initially defined	A symbol for organization unit was not defined prior to the interventions. During the study, none of the interventions needed to visually depict the concept of organization unit. Thus, a symbol for this concept was not defined in this research.

Technology	
	A simple dark purple rectangle was selected to represent technology. A rectangle was chosen because rectangles are commonly considered to be more technical (Bar & Neta, 2006). Dark purple was used because it is a little less stark than black. However, the use of dark purple for the technology could reduce perceptibility discriminability between technology and value. Although value is a different shape, it is also purple, although a lighter shade. We did consider using navy blue. However, this is still close to purple and could decrease perception discriminability with information. We anticipated it would be more likely for technology and information to be on the same diagram than would technology and value and therefore chose to use purple. Attention was paid to any indication of perceptual confusion between value and technology during the interventions.

Information	
	A medium blue rectangle with one rounded corner and one corner cut off at a 45-degree angle was selected for information. The flattened and rounded corners and blue colour distinguish information from the technology symbol.

Guide	
	A yellow rectangle shaded with light yellow with a bottom corner flipped up was selected for guide. A rectangle with sharp corners was considered suitable as guides are generally well defined and documented. The flattened bottom corner and yellow colour distinguish guide from information. The sharp corners distinguish guide from challenge. Guide and challenge did not both appear on any of the diagrams we created so we were unable to assess any perceptual confusion.

Channel	
Not Initially Defined	Prior to the interventions a symbol for channel was not defined. An icon of a delivery truck is often used in the Business Model Canvas diagram. However, a delivery truck does not seem to be an intuitive representation of a service delivery channel and would not be meaningful in the healthcare context. The concept of channel was not used in any of the interventions and a symbol was not defined.

Infrastructure	
	A dark brown rectangle with the corners inversely curved was selected to represent infrastructure. This shape was chosen because it was one of the few remaining shapes in PowerPoint that could

	accommodate a multi-word label in an easy to read format. Dark brown was chosen because it was the only bold colour not yet used by any other visual semantic construct in this grammar. Dark brown and purple can be difficult for people with colour blindness to distinguish, but the dark brown and purple symbols do have distinguishable shapes.

Once an initial design of the visual constructs was completed, the next step was to draft a basic conceptual modeling method to define the design principles for the diagrams.

3.5 Principles for Diagram Layouts

The purpose of the conceptual modeling methods for this visual language is to provide guidelines for laying out the visual constructs in a manner that realizes the two goals of quick and easy comprehension and readily apparent identification of information most relevant to the stakeholder reading the diagram. As described earlier, to reach these two goals the modeling method should reduce intrinsic cognitive load were possible and eliminate extraneous cognitive load as much as possible.

To reduce intrinsic cognitive load, the PoN principle of complexity management suggests a modular set of diagrams rather than a single all-encompassing diagram (Moody, 2009). This enables the diagram reader to focus on a smaller number of concepts at one time. The recommendation that the conceptual modeling grammar be aligned to the diagram users' internal mental representations (Chabris & Kosslyn, 2005) provided the basis for determining the initial construct grouping. We grouped the visual semantic constructs into the same two groups as the

ontological constructs, using the two sensemaking interrogatives – why change and what needs to change. With this grouping we determined we would have at least two different types of diagrams. Each type of diagram had the purpose of answering one of the sensemaking interrogatives and thus should only contain the visual semantic constructs necessary to answer the specific interrogative.

The PoN principle of cognitive integration recommends that there be a mechanism for easy integration of concepts across diagrams. Studies have shown that when engaging in sensemaking, many people first try to understand the specifics of change related to themselves and then attempt to understand where they fit in the full picture (Balogun et al., 2015; Gioia & Chittipeddi, 1991). To enable this stakeholder centric view in sensemaking, the concept of stakeholder has been identified as a common link across all diagrams. The second common link is the concept of value, which reinforces the benefits of the change. The third common link is the concept of goal. Including the goal on each diagram could reinforce a consistent reminder of what the change is expected to be achieve. Figure 7 describes the two groups of ontological

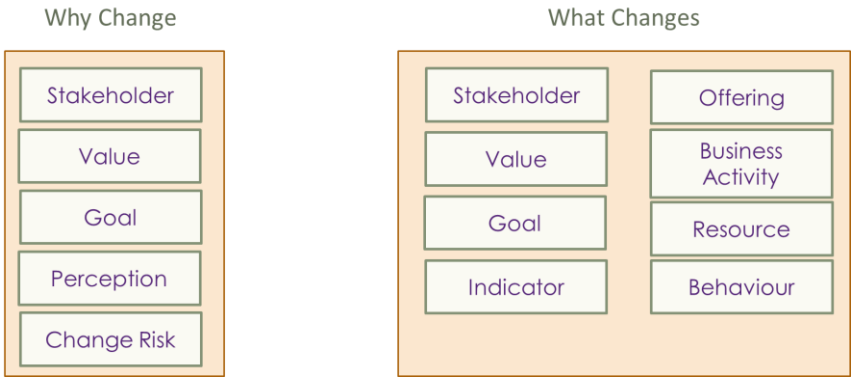


Figure 7 - Semantic Construct Grouping

constructs that were initially defined for the two types of diagrams. This grouping remained unchanged in the first two interventions but was adjusted in the third intervention.

In anticipation of the potential for more types of diagrams and to promote cognitive integration across the diagrams we determined to define a set of hierarchical conceptual modeling methods that followed the object-oriented modeling approach and implemented the principle of inheritance. We defined a top-level conceptual modeling method that contained common design principles across all diagrams to support cognitive integration. We then defined individual modeling methods for each diagram type. These second level modeling methods inherited the design principles of the top-level method and added additional design principles specific to the associated diagram type. Following this approach would enable further levels of diagram sub-types to be defined with associated further specifications of the modeling methods.

The top-level modeling method contained diagram layout principles common to all diagram types to enable a stakeholder centric view of the change. This supports the common sensemaking of approach taken by individuals whereby they first seek to understand how they individually fit in the change and then seek to understand the larger organizational picture of the change. Building on the lane concept from BPMN, the first layout principle defines that instances of stakeholders will be listed vertically at the left of the diagram. The second layout principle builds on the first rule and defines that instances of visual semantic constructs related to a specific instance of a stakeholder should be placed in horizontal proximity to the symbol of the related stakeholder. These two principles enable stakeholders to quickly identify themselves in the diagram and any other constructs directly related to them. Then they can scan the diagram to gain a sense of how they fit in the overall change and how their actions may impact the success of the change by identifying who and what else is involved in the change.

To improve the ease of comprehension we defined two additional layout principles to reduce visual noise by implementing the PoN principle of graphic economy. One principle

identifies that lines indicating flow or other relationships should be avoided wherever possible. The complementary layout principle identifies that relationships between instances of visual semantic constructs should be indicated by spatial proximity as much as possible. To adhere to the PoN principle of semantic clarity, we defined additional principles to guide how spatial proximity should be used to represent different type of relationships. As mentioned above, the "contains" relationship is represented by spatial enclosure. For example, Figure 8 depicts an information type that "contains" sub-types of information. We defined another principle that extends spatial enclosure to spatial overlap. Placing a shape partially over one or more shapes can be used to depict a shared relationship between the entities represented by the shapes. For example, Figure 9 depicts a process shape that overlaps two technology shapes to represent that both technologies are involved in the process. Figure 10 depicts a combination of spatial enclosure and overlap to depict that the process is contained within the technology. This represents that the process is fully automated, and this automation is shared across two technical systems. The final spatial principle identifies that flow should be indicated by horizontal sequence of symbols from left to right. Figure10 also illustrates this principle in depicting the sequential flow of the processes.

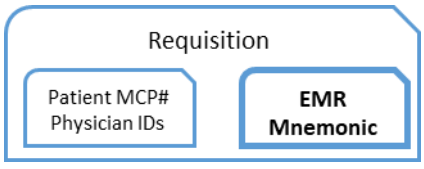


Figure 8 - Spatial Enclosure

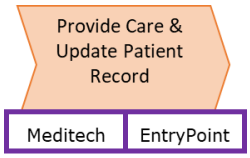


Figure 9 - Spatial Overlap

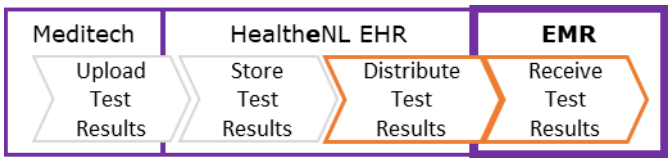


Figure 10 - Combination of All Three Spatial Layout Principles for Depicting Relationships

To increase the ease of interpreting the modeling grammar, another common diagram layout principle was defined based on the PoN principle of dual coding. This principle states that labels should be used as much as possible to identify the types of semantic constructs, but not so much as to become visual noise. Based on the PoN principle of graphic economy, the final common layout principle defines that an instance of a concept should only be shown once on the diagram unless additional specific meaning could be inferred by depicting the semantic construct multiple times.

The definition of modeling methods specific to the diagrams types was left to be developed during the interventions when the diagrams were designed. These definitions are described in the subsequent sections that describe the intervention findings. However, we did define a design principle for each diagram type to specify the set of semantic constructs that could be included on the diagrams generated by each diagram type.

The initial theoretical definition of the three modeling methods is summarized below. Each principle is uniquely identified to enable easy referencing in subsequent sections of this thesis. A description and rationale are provided for each principle. The rationale consists of the intended outcome of the principle and the specific theory, as explained above, for anticipating that this principle can contribute towards the intended outcome. Clearly and consistently defining the rationale for each design principle in this way can aid in the reduction of design theory indeterminacy during artifact deployment (Lukyanenko & Parsons, 2020).

3.5.1 Conceptual Modeling Methods Definition

Conceptual modeling method "A" describes the design principles to be applied to all diagram types. Conceptual modeling method "Y" describes the design principles for the diagram type that depicts why the change is proposed. Conceptual modeling method "T" describes the design principles for the diagram type that portrays what is being proposed to change.

ID	Design Principle Description	Intended Outcome	Theoretical Justification
A.1	Stakeholders will be clearly identified on every diagram	Diagrams are consistently stakeholder centric.	Sensemaking Theory, PoN Cognitive Integration
A.2	Lines indicating flow or other instance relationships should be avoided.	Reduce visual noise and reduce perception of complexity.	PoN Cognitive Fit
A.3	Construct relationships should be indicated by spatial proximity.	Reduce perception of complexity.	PoN Semantic Transparency
A.4	Items related to a specific stakeholder should be placed in obvious proximity to the stakeholder symbol	Enable stakeholders using the diagram to quickly identify items pertinent to themselves.	Sensemaking Theory, Builds on the BPMN swim lane construct
A.5	Temporal order of instances should be indicated by horizontal sequence of symbols.	Where relevant, the general sequence of activities can be easily understood	PoN Graphic Economy

ID	Design Principle Description	Intended Outcome	Theoretical Justification
A.6	Text labels should be used in addition to visual distinctions to identify the types of semantic constructs	Enable diagram users to quickly understand the semantic constructs with minimal explanation.	PoN Cognitive Fit, PoN Dual Coding
A.7	The symbol for each semantic construct must be visually distinguishable from others by shape or icon and, additionally where possible, by colour.	Reduce the cognitive load to comprehend the diagram. Users can quickly and accurately identify what a symbol represents	PoN Perceptual Discriminability, PoN Visual Expressiveness
A.8	A visual semantic construct will be represented by the same symbol across all diagrams.	Reduce the cognitive load to comprehend the diagram. Reduce the initial explanation needed for each diagram	PoN Semiotic Clarity, PoN Cognitive Integration
A.9	An instance of a semantic construct should only be shown once on the diagram.	Reduce the cognitive load to comprehend the diagram. Users can quickly identify the symbol they want to refer to when discussing the diagram.	PoN Graphic Economy

ID	Design Principle Description	Intended Outcome	Theoretical Justification
Y.1	Only instances of the following visual semantic constructs should occur on a Why Change type of diagram: Stakeholder, Value, Goal, Perception, Change Risk	Stakeholders can clearly understand the motivation for the change	Sensemaking Theory, PoN Complexity Management
T.1	Only instances of the following visual semantic constructs should occur on a What Changes type of diagram: Stakeholder, Value, Goal, Indicator, Offering, Business Activity, Resource, Behaviour	Stakeholders can clearly understand the scope of the change, including what is changing and the impact to themselves	Sensemaking Theory, PoN Complexity Management

This concludes the design of the initial draft of the conceptual modeling grammar and modeling methods. Our theory-based design was not a complete design. We had not defined symbols for all the semantic constructs. The modeling methods were still quite abstract and did not provide enough guidance to repeatedly generate similar diagram layouts. Our intent was to provide a theoretically sound structure for the visual language that we could build on and elaborate in partnership with potential users of the language. The next chapter explains the method used for further iterative design of the grammar and modeling methods.

4 ACTION DESIGN RESEARCH METHOD

4.1 Intervention Purpose

The potential value of engaging individuals in the design of solutions to problems that impact them has been recognized in literature at least as early as the 1940's (Bartunek & Woodman, 2015; Coch & French, 1947; Lewin, 1945). Involving individuals in designing an artifact they will use to solve a business need has been advocated by information systems researchers since the 1960's (Markus & Mao, 2004) and increasingly by product design researchers since 2000 (Shah & Robinson, 2007). Experience-based co-design research is becoming more prevalent in the healthcare space (Greenhalgh et. al., 2016). These approaches frame research as a creative endeavor where existing theory is often insufficient (Greenhalgh et al., 2016; Hevner et al., 2004) and with a core focus on human experience (Greenhalgh et. al., 2016). Potential solution stakeholders or product users can provide greater insights into their need for the solution or product and identify features that are most important to them (Shah & Robinson, 2007). However, motivating such individuals to engage in designing an artifact can be challenging (Markus & Mao, 2004; Shah & Robinson, 2007) for similar reasons that it is difficult to engage them in defining organizational change; they are lacking available time and mental energy.

Performing the next stage of the design through interventions within the context of ongoing service change initiatives enabled us to overcome the participant availability challenge. This form of research is commonly called action research. The essence of action research is to develop theory through intervening in a problem situation to effect change that improves the situation for the participants (Bradbury-Huang, 2010). Since our research goal was to design a visual language to engage busy stakeholders in scoping service delivery change, we selected

intervention situations that were having challenges in this very area. Healthcare was chosen as the organizational setting for each intervention because healthcare providers and administrators in Canada are generally extremely busy. Thus, they are typical of the busy stakeholders we wanted to engage with the visual language. Each intervention had a specific objective which was related to their need to overcome a challenge in engaging their stakeholders. Many of the participants in these interventions were motivated to engage in design activities in the hope that their change design challenges could be overcome.

In action research, knowledge is developed through reflection on the impacts of the intervention. The intervention is informed by theory, but the intervention is not a test of a theoretical hypothesis. The intervention itself evolves as it progresses via joint reflection by the researcher and the intervention participants. Thus, the participants are empowered to contribute to the improvement of their situation (Bradbury-Huang, 2010). Lewin (1947) proposed that joint responsibility between researchers and participants for theory development and evaluation would ensure the relevance of the theory and improve the validity of the reflection of the generated knowledge.

4.2 Intervention Research Method

Design science research (DSR) has a similar aim to that of action research but with a different objective of designing artifacts rather than describing phenomenon. Sein et al. (2011) proposed action design research (ADR) as a formal method of incorporating action research into DSR (Figure 11). “ADR conceptualizes the research process as containing the inseparable and inherently interwoven activities of building the artifact, intervening in the organization, and evaluating it concurrently” (Sein et al., 2011, p.37). Although ADR was developed primarily for

information systems research, it is applicable to the design of any artifact used as a communication or decision-making tool (McCurdy et al., 2016).

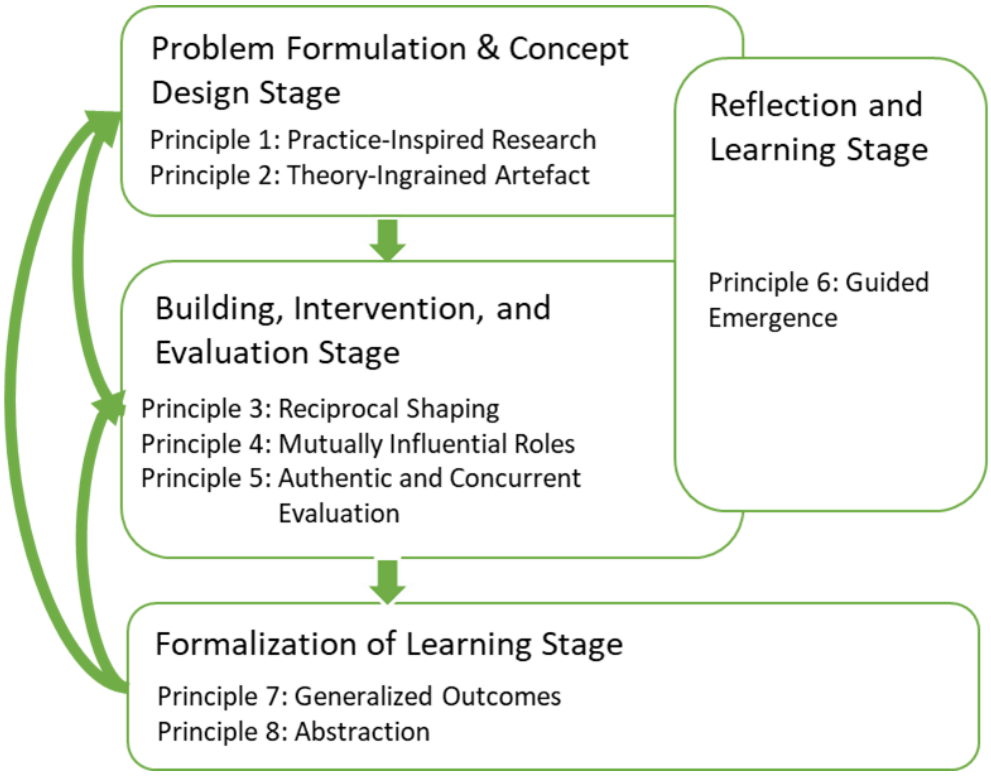


Figure 11 - ADR Method (adapted from Sein et. al., 2011; Sein & Rossi, 2018)

Following the ADR method enabled further design and evaluation of the visual language in the context of intervening in active organizational change initiatives. With the inclusion of some of the extensions proposed by Mullarkey and Hevner (2019) and Sein and Rossi (2019), the ADR method was applied to enable abductive and iterative development of the visual language across three interventions in three health care organizations.

ADR is implemented in four stages, some of which may be executed iteratively or in parallel. These four stages are guided by eight principles. The following sections describe the four ADR stages and how each stage was implemented in this study.

4.2.1 ADR Stage 1: Problem Formulation & Concept Design

The purpose of the ADR method is to solve a practical problem through designing and using theory-ingrained artifacts. Field problems are viewed as "knowledge-creation opportunities (Sein et al., 2011, p. 40). Each intervention in this study occurred in a health care change initiative that was seeking to overcome challenges in engaging stakeholders to reach a common understanding and/or co-design the scope of a service change. Each intervention had a specific objective defined in collaboration with the organization that was pertinent to addressing their identified practical challenges. Fundamental to design science research is that the "artifacts created and evaluated are informed by theories" (Sein et al., 2011, p. 40). Therefore, each intervention also defined design objectives founded on theory for the proposed artifact. During stage 1 of each intervention, the scope of anticipated conceptual modeling methods was identified. This formed the concept design for the study. The concept design included methods developed in any previous interventions as well as new methods to generate new types of diagrams.

4.2.2 ADR Stage 2: Building, Intervention and Evaluation

Each intervention progressively designed the conceptual modeling grammar by building and refining conceptual modeling methods that generated scripts and evaluating the effectiveness of these scripts within the intervention. This stage was characterized by reciprocal shaping of the artifacts within the organizational context and shaping of the intervention by the artifacts (Sein et al., 2011, p. 43). The purpose and scope of each conceptual modeling method was determined by the purpose and information needs of the intervention. In turn, the activities within the intervention were influenced by the design and use of the diagrams.

The roles of the researcher and the organizational leaders in ADR are mutually influential (Sein et al., 2011, p. 43) through engaging in joint evaluation, mutual learning and collaborative decision making. In the first two interventions, as the diagram types were being formulated, the intervention process unfolded one step at a time. Each step was identified and defined through mutual agreement between me and the change leaders, to achieve the objectives of the intervention and the artifact design. Joint evaluation occurred after each step in the intervention to determine the next step. Together we also reflected on and refined the intervention process and the artifact design as needed during the intervention, drawing on the organization leaders' knowledge of the stakeholders and my knowledge of applicable theory.

Evaluation of the artifacts and the intervention occurred concurrently with the design and use of the artifacts. This implemented a core principle of ADR that "evaluation is not a separate stage of the research process that follows building … Instead, decisions about designing, shaping, and reshaping the ensemble artifact and intervening in organizational work practices should be interwoven with ongoing evaluation." (Sein et al., 2011, p.43). Design, use, and evaluation is an iterative process repeated multiple times for each intervention. Collaborative activities were scheduled throughout each intervention to evaluate the artifacts and the intervention processes. Within ADR, particularly during early iterations, controlled evaluation is difficult due to the emergent nature of the artifact. Authentic reflection and feedback from participants are considered more important than controlled settings in ADR (Sein et al., 2011, p. 44). We promoted reflection and feedback by giving all participants opportunity to contribute to design changes and reflect on the value of those changes.

The purpose of the evaluate stage in DSR is to determine how well the artifact achieves its purpose (March & Smith, 1995, p. 258). Achievement of purpose can be evaluated in terms of

quality, validity, utility, and efficacy (Hevner, et. al., 2004, Peffers et. al., 2008, Gregor & Hevner, 2013). The quality of the visual language can be evaluated in terms of how well it aligns with relevant theories, such as the theory embodied in Moody's (2009) Physics of Notations. The validity of the visual language means that the language "works and does what it is meant to do" (Gregor & Hevner, 2013 p.351). The efficacy of the visual language describes how well the visual language works (Hevner et. al., 2004) within the problem space. For example, the efficacy of the language would be low if time constraint is a significant characteristic of the problem space and it is time consuming to learn and use the language. The utility of the visual language assesses its perceived usefulness or value within the problem space (Gregor & Hevner, 2013).

4.2.3 ADR Stage 3: Reflection and Learning

The third stage, reflection and learning, operated concurrently to stages 1 and 2 and is based on the principle of guided emergence. This principle "emphasizes that the ensemble artifact will reflect not only the preliminary design (see Principle 2) created by the researchers but also its ongoing shaping by organizational use, perspectives, and participants (see Principles 3 and 4 respectively), and by outcomes of authentic, concurrent evaluation (see Principle 5)" (Sein et al., 2011, p. 44). The results of the concurrent evaluation of the conceptual modeling grammar, the domain ontology and the intervention process were used to determine modifications to the concept design, the artifacts, and the remaining activities in each intervention.

Design changes to the conceptual modeling grammar and the intervention process were identified through reflection and evaluation and then developed in alignment with PoN and sensemaking theories. Where there seemed no apparent way to align the design change with theory and meet the intervention objectives this was specifically noted, and greater attention was

given to reflecting on the effectiveness of these design changes. Design changes made to the conceptual modeling grammar were assessed to identify any corresponding modifications needed to the domain ontology.

4.2.4 ADR Stage 4: Formalization of Learning

Formalized learning includes generalized outcomes such as (1) generalization of the problem instance, (2) generalization of the solution instance, and (3) derivation of design principles from the design research outcomes" (Sein et al., 2011, p.44). The problem instance was already generalized at the start of the research and interventions were selected based on their alignment with the generalized problem. Formalized learning at the end of each intervention was focused on artifact design principles relevant to the next intervention and identification of solution approaches that could be used in the next intervention. At the end of research, learning across all three interventions was formalized. The solution instance was generalized by describing how the use of the artifacts contributed to achieving the objectives of the interventions and how this addressed the general problem.

Per March and Smith's (1995) framework, the formal definition of the artifact is also considered a generalized solution. The final definition of the ontology, the modeling grammar and modeling methods, including all modifications made during the interventions, is considered a generalized solution as this definition could be used to generate diagrams in other organizational change initiatives. Derivation of design principles for the conceptual modeling grammar and modeling methods was accomplished by analyzing the design choices and the reasons behind those design choices and then assessing this analysis for any elaborations to the design principles described in the kernel theories, such as PoN.

4.3 Intervention Settings

The aim of this research was to design a visual language for describing the scope of organizational change to help reduce the gaps and inconsistencies in stakeholders' understanding of the change scope. The key challenge that the design of the visual language needs to address is the constrained availability of these stakeholders due to scarcity of time and mental energy. In the theoretical analysis and design performed in the previous chapter, we defined two design goals for this visual language:

a) The diagrams constructed using this language must be easily understood with minimal explanation; and
b) Information relevant to specific stakeholders must be readily apparent to them.

All three interventions were performed within a public healthcare organization, where it is quite common for clinicians and healthcare administrators to have heavy workloads and little opportunity for backfilling when temporarily removed from operational duties. In all three interventions, the participants were experiencing some level of availability constraint. In each intervention, change was desired by the participants. The challenge was defining and/or reaching understanding and agreement on what that change encompassed for everyone involved. Thus, each intervention setting fit the generalized problem space where the key challenge was lacking time and energy for engaging in scoping change. The specific characteristics of each intervention are described in the intervention stories in chapter 5.

One of the advantages we experienced in performing interventions in healthcare was that many of the participants were already trained, as part of their professional education, and experienced in the critical thinking and analysis skills necessary for participating in artifact evaluation. In Canada, in recent years there has been a strong emphasis on service quality

improvement and continual process improvement. Thus, the healthcare participants in the interventions all had exposure to various methods of evaluating tools and processes. This continual improvement exposure reduced reluctance to identify issues or opportunities for improvement with the artifacts that is common to research participants. The process and tool evaluation experience of many of the participants also increased their ability to articulate their feedback clearly and concisely. In addition, the organization in the third intervention also operated a medical research lab and a few of the participants were skilled in recording observations and reflecting on their own experience.

4.4 Data Collection & Ethics

Qualitative data was collected in this ADR project from multiple perspectives (researcher, organization leadership and organization team members) and multiple sources (observation, ethnographic reflection, interview, and survey). Collecting various perspectives on the same event from multiple people in different roles is a qualitative form of data triangulation (Eisenhardt, 1989). This protects against researcher and participant bias and may increase the internal reliability of the data (Bell & Bryman, 2015). Using multiple sources to collect individual perspectives of the artifacts and intervention can aid in increasing the richness and completeness of the data, which adds to the data's quality and validity (Miles, 1994).

Much of the data was collected from observation and ethnographic reflection. A research participant or I documented observations during meetings, where we were able to observe the artifacts being used without participating in the interaction. Where I was required to facilitate or participate in the meeting, I documented ethnographic reflections within 24 hours of the meeting conclusion. Informal, open ended interviews were used to gather reflection data from research participants during the interventions and I documented the responses during the interviews. Sem-

structured open-ended interviews were used to gather reflection data from research participants during the design evaluation activities in the interventions. Some of these evaluation interviews were audio recorded where the participants felt comfortable. In one intervention we also used a very brief survey to gather reflection data from the participants after a workshop. However, as most of the research participants were extremely busy, there was little uptake for filling in surveys. Table 3 summarizes the types and volumes of data collected.

One of the risks to data validity when the researcher actively participates in the intervention is that participants develop a positive relationship with the researcher and therefore do not want to say anything negative (Bell & Bryman, 2015). To mitigate this risk, we employed techniques to build on the continuous improvement mindset developed by many of the participants in previous healthcare service quality initiatives. In each of the three interventions, effort was made to turn any positive relationships that developed between the participants and me, into an asset to data quality rather than a risk. This was done by constantly reminding the participants that the purpose of the research was to develop a helpful mechanism and eliminate as many potential design weaknesses as possible. Participants were consistently encouraged by me and their organization leaders that it was most beneficial to the research as well as to themselves to discover what worked, what did not work and what could work better. We used two targeted, open-ended questions during our semi-structured reflection interviews to minimize the risk of leading participants in a certain direction (Bernard et al., 2017). Participants were first asked what they liked or found helpful about the diagrams they were using. They were then asked to identify anything about the diagrams that was a bit confusing or created a “bumpy” experience and reminded that this would likely not be the same for everyone. We also employed

non-specific probing questions to increase the richness of the data and the potential for discovering new insights about why certain features were helpful or hindering.

Table 3 - Data Collection Summary

Data Collection	Intervention 1 14 participants	Intervention 2 13 participants	Intervention 3 45 participants
Observations	1 meeting	9 meetings	10 meetings
Reflections	5 meetings	3 meetings	40 meetings
Interviews	3 individuals	2 individuals	10 individuals
Surveys	none	none	1 survey – 8 responses

During ADR stages 1 through 3 of each study, I documented ethnographic reflections after most of the intervention sessions. Ethnographic reflection is subjective and describes the researcher's experience and recalled observations about the event or situation (Stewart, 1998). Ethnographic reflection during a design process includes reflection on the experienced and observed actions and reactions of the participants using the artifact in the intervention event. This reflection does not make judgements but poses questions and potential responses to the motivations and impacts of participant actions with the artifact. Ethnographic reflection provides a deep description of the use of an artifact that can be mined for potential design improvement insights (Crabtree et al., 2012).

When I was not facilitating the session, I recorded observations during the session using the perspective of knowing in practice (Orlikowski, 2002). This perspective asserts that knowledge is grounded in practical activities and situated in interactions between people and objects. These observations focused on participant interactions with each other and the artifacts.

In some of the sessions, one of the change leaders was solicited to record their own observations. In the third intervention, the organization provided an administrative assistant to record observations of each large group session. The administrative assistant and the change leaders were given a brief guideline of how to watch for participant interactions and what type of data to record. This guideline is documented in the appendix. Observations recorded by organization members not only gave them opportunity to develop greater insights into the unfolding change process, but also partially mitigated the inevitable research bias incurred in researcher observations (Bell & Bryman, 2015).

In line with ADR stage 3 principles, I also facilitated sessions with some of the participants to reflect on and evaluate the design and use of the grammar and domain ontology. I documented these sessions within twenty-four hours of the session to reduce selective recall. Session summaries included the participant's perspective on the effectiveness of the intervention, how the artifacts affected the intervention, design changes made and the reason for the design change. These reflection sessions were not audio recorded because the organization leaders felt that the participants would be more honest and forthcoming without audio recording. A version history was kept of all diagrams developed during the interventions and these versions were linked to the summarized design changes. These joint reflection and design modification sessions were critical to mitigating researcher bias and developing a design that considered multiple user perspectives.

At the end of each study, semi-structured interviews were conducted with the participating change leaders, and any other willing participants, concerning (a) their experience designing and using the artifacts; (b) their observations of others doing so; and (c) their assessment of the achievement of the intervention and design objectives. A few of these interviews were audio recorded where the interviewees felt comfortable. These recordings were transcribed, and each

interviewee was given the opportunity to review the transcript and request anything to be removed. In addition, the transcripts were edited to remove any personally identifying information. The original audio recordings were then deleted to ensure they could never be made available to any future non-academic inquiry. This encouraged interviewees to speak freely knowing they could censor their comments of anything they inadvertently said that could put anyone at risk for any reason.

The organizations participating in the research are not identified in this thesis or any published material. All participants remain anonymous. Participants are identified only by a code within the recorded data and no personal information was collected. This research has been reviewed by the Health Research Ethics Board and approved by the Interdisciplinary Committee on Ethics in Human Research at Memorial University of Newfoundland.

4.5 Data Analysis

In ADR research, the purpose of data analysis is to evaluate the design theories developed and the artifacts produced, including the impact of using the artifacts within the interventions. Different evaluation approaches can be taken within ADR depending on the circumstance of the design activities and the involvement of participants in evaluation. We used the "human risk and effectiveness" evaluation strategy described in Venable et al.'s (2016) design science evaluation framework. This strategy supports the design research goal of a useful and beneficial artifact in the participant's real context (Venable et al., 2016, p. 82). It is most appropriate when the major design risk is social or related to user adoption. This strategy emphasizes early formative evaluations, starting with artificial evaluations and quickly moving on to naturalistic evaluations. Summative evaluations, which focus on effectiveness of the artifact, were performed at the conclusion of the interventions.

4.5.1 Formative Evaluation

During the early stage of designing the visual language the evaluation was artificial and embedded in the initial design. Each visual construct was evaluated against the PoN principles as described in the previous chapters. After the initial design, ADR evaluation is mostly naturalistic because it is performed in a real environment, and the evaluation tends towards interpretivism (Sein et al., 2011, p. 81). During the ongoing reflection and evaluation activities of ADR, the evaluation approach is formative to support the improvement of the design of the artifact in assisting the purpose of the intervention (Sein et al., 2011, p. 78).

Naturalistic formative data analysis in this research started with analyzing collected data to find positive and negative reactions and comments related to the artifact under evaluation. Due to the short time frames in iterative design, this review is generally informal. In each intervention, early formative evaluation of the artifacts was accomplished through discussion with organizational members who were participating in designing the artifacts and leading the intervention. The discussion referenced documented data and was augmented by participants' recollections and reflections. This analysis was aimed at collaboratively identifying themes or patterns in the participant usage and reaction to the artifacts. These themes were then used to identify areas for improvement to the artifact. At this point the analysis became abductive (Sein & Rossi, 2019) and we looked to theory to identify potential reasons for the participants' reactions to features of the artifact and corresponding guidelines to inform the design change.

4.5.2 Summative Evaluation

Summative evaluations of the implemented artifacts assess the effectiveness of the design principles in achieving the intended outcomes (Sein et. al., 2011). Together with some of the participants, I performed informal summative evaluations at the conclusion of each intervention.

These evaluations occurred during one-on-one semi-structured interviews in which we reflected on the effectiveness of the diagram design and the underlying ontology. Effectiveness was discussed in terms of the participant's experience using the diagrams and their subjective assessments of how using the diagrams contributed to achieving the intervention objectives. From these reflections, we identified issues and opportunities for improving the design of the diagram that could be reviewed in the next intervention.

Since we were developing a novel language, none of the participants had previous familiarity with the tool. In addition, each intervention occurred in a different organization and each participant was involved in only one intervention. Thus, each participant started the intervention with no previous experience of the language, and we were able to minimize any risk previous experience might have on the evaluation of the efficacy of the language.

An informal summative evaluation was conducted again at the start of the second and third interventions with the intervention leaders. The diagram designs were reviewed for suitability for the intervention's objectives. Previous and newly identified issues and opportunities for improvement were discussed and those most relevant to the intervention were included in the scope of design activities.

A formal summative evaluation was performed after the second intervention and again at the end of the research project. This consisted of content analysis of the data collected, focusing on the utility and efficacy of the visual language using the measures described in the next sub-section. After the first round of coding, I utilized abductive reasoning to identify theoretical concepts that explained the coding results. In some instances, this led to further content analysis and coding for new indicators related to the identified theory. This iterative combination of

informal and formal summative evaluation enabled each intervention to build on the findings of the previous iteration and advance the design of the visual language.

The first intervention was the most straight forward one. The key problem the organization wanted to address was communicating the scope of change to those implementing it. Existing communication mechanisms in the pilot implementation had created confusion and resulted in delays and implementation process gaps. This situation enabled us to compare the effectiveness of the visual language against the existing communication mechanism.

The second intervention occurred earlier in the change process. The scope of change had been explored and a high-level consensus reached. However, in this situation the challenge was the lack of response from stakeholders to review and approve the textual description of the scope of change. This intervention enabled us to compare the effectiveness of using the visual language to engage busy stakeholders as well as the effectiveness of the visual language in refining and deciding on the scope of change.

The third intervention was the most complex. This intervention occurred at the very beginning of defining the scope of change. The challenge was engaging all stakeholders to collaboratively define the change and reach consensus, where previous efforts had failed. In this intervention we were able to evaluate not only the effectiveness of the visual language in communicating change scope, but also its use in identifying and designing the scope of change collaboratively with multiple stakeholder groups. These three interventions enabled us to develop and test the visual language as a tool in three progressively complex stakeholder engagement situations from change communication, to review and approval, and finally collaborative design.

4.5.3 Evaluation Measures

The objective of artifact design theories is to prescribe principles for the construction of the artifact that will achieve a desired outcome through deploying artifact. However, defining valid and reliable measures for evaluating the effectiveness of design theories is a common challenge in design science (Lukyanenko & Parsons, 2020). When an artifact is implemented in an organization, it becomes part of an open system. Not only does the artifact have numerous features that interact with the system, but the open system has a myriad of potential moderating and mediating factors that influence the effectiveness of the artifact design.

In addition, due the inherent nature of a principle, the design principles that guide the implementation of artifact features are not one-to-one principle to design implementation mappings. This results in design indeterminacy (Lukyanenko & Parsons, 2020). For example, one of the design principles defined for this visual language, "Stakeholders will be clearly identified on every diagram" could be implemented in a variety of ways. What is clear in one diagram layout might not be clear in a different diagram layout. In addition, what is clear to one person familiar with the diagram may not be clear to someone else who has not previously seen this diagram layout. Therefore, it is difficult to ascertain if the diagram was more or less effective due to the design principle or due to the specific implementation of the design principle.

We sought to increase the validity and reliability of our measures in two ways. First, we defined objective measures for diagram effectiveness directly associated with our two design goals. We defined the same objective measure for "minimal explanation of the language" across all interventions. This measure included the duration in minutes of the explanation. It also included the scope of the diagram layout explanation including the diagram purpose and the number of concepts and relationships.

It was more difficult to define a direct objective measure for "easily understood" because we needed to measure this in real time during the intervention and so could not apply comprehension measurement techniques common employed in controlled experimental settings. Instead, we used indirect measurements, such as the number of questions a participant asked about the meaning of the diagram and the amount of input provided that was relevant to the purpose of the diagram.

The third measure, "information relevant to specific stakeholders must be readily apparent to them", was even more difficult to objectively assess. Again, since we were not in a laboratory setting, we could not use precise measuring techniques such as eye tracking. Thus, we defined measurements for indirect indicators such as, how long they studied the diagram before providing their feedback, in conjunction with whether their immediate feedback was on information that we expected would be most relevant to them. We discovered that we did not always know what information was most relevant to some individuals. When feedback was given on depicted information we were not expecting, we asked additional questions to confirm the importance of the information or noted this from their own spontaneous statements.

The ADR research process concluded with a review of all the design modifications made during the interventions and an integrated review of the summative evaluations across the three interventions. The next chapter describes the process of each intervention, discusses how the various design modifications were identified and developed, and summarizes the findings for each intervention. The final chapter of this thesis elaborates the overall summative findings.

5 THREE INTERVENTIONS

Three intervention settings in healthcare were identified in succession, through meetings with leaders or facilitators of healthcare service change initiatives. The first intervention was a multi-phased project to implement a new digitized service to physicians. This project had encountered challenges communicating the scope of change to impacted stakeholders in its first rollout. These communication challenges resulted in implementation problems that created extra work for the project team and stress for the impacted stakeholders. The second intervention was an initiative to develop a business case for transforming the way rural hospitals serviced in-patients. The initiative had a good start engaging stakeholders to discuss challenges and envision a new approach. However, these same motivated stakeholders were unable to find the time to review and provide feedback on the proposed documented approach and business case. The third intervention was a healthcare organization that was looking for a new and effective way to engage all their staff in prioritizing and committing to service transformation within tight budget and staff availability constraints. This organization had a history of unsuccessful change initiatives.

I selected the three interventions based on best fit with the following criteria. Firstly, the change initiative was experiencing or expected to experience challenges communicating or defining the scope of change. Secondly, the change leaders and change participants were willing to explore the use of a visual language and contribute to its design. Willingness to explore and reflect is an essential characteristic that underpins four of principles of ADR: reciprocal shaping; mutually influential roles; authentic and concurrent evaluation; and guided emergence. I removed from consideration those initiatives that were looking for someone else to provide a quick and easy solution or where participants were not interested to participate in the research

activities. The final criterion for selection was that the change participants were supportive of change but constrained in their availability to participate in understanding or defining the scope of the change. This criterion was important to reduce confounding factors that may be influencing stakeholders' level of engagement in the early stages of the change. We wanted to ensure as much as possible that the prime factor hindering stakeholder engagement was availability constraints and not lack of interest or personal resistance to the change.

To promote adherence to the first two criteria we started each intervention by defining an intervention objective and an artifact design objective with the change leaders. The change leaders and I then jointly outlined the roles and activities for the intervention. This was presented to the core change project team and refined with their input. The change leader solicited their commitment to engage in the intervention. The activity plan for each intervention was flexible. In each case the change leaders and I collaboratively modified the activities as the intervention unfolded based on the results of our periodic reflection sessions and the availability of the participants. The following sub-sections describe how each of these interventions were structured, how they evolved and how each intervention contributed to the design of the conceptual modeling grammar and modeling methods.

5.1 Intervention 1: Communicating Change Scope

5.1.1 Intervention Background

The setting of the first intervention was a health organization charged with the development and implementation of core components of an electronic health record shared across multiple public health authorities and private medical practices. The vice president (VP) responsible for clinical programs identified in the exploratory interview that engaging physicians effectively was very challenging. She expressed that fee for service clinicians were concerned

about the amount of time taken up in unpaid activities. In addition, she explained that all physicians had a heavy load of patients and were "very concerned about wasting scarce and precious time."

One of the projects, for which the VP was responsible, had successfully started the implementation of electronic medical record (EMR) technology for all public medical clinics and private practices. The next stage was a project to implement a mechanism to proactively distribute the results of laboratory diagnostic tests from the central repository directly to the EMR used by the requesting physician and/or other appropriate clinics or physicians. The project team had developed the distribution software and implemented a pilot with a small group of private practices, community clinics and a local hospital laboratory. During this pilot, the physicians experienced confusion when selecting the options identifying which lab test results they wanted to receive. Some physicians had been inundated by lab results they did not expect or want, and others had not received lab results they were expecting. In addition, critical routing information was often incorrectly entered by the hospital laboratory staff causing the lab result to be distributed to the wrong EMR or not distributed at all. The project team felt that the clinical and administrative stakeholders did not understand the scope of the change nor the structure of the solution.

The VP discussed the research opportunity with the EMR project director, and they decided this project could benefit immediately from engaging in research to design a visual communication mechanism that would clarify the scope of the change to all stakeholders. The existing communication of the scope of change for this lab result distribution service consisted of a web page explaining the benefits of the new service, written documents explaining the change along with forms that needed to be completed and a table of distribution options. In addition, the

project team was counting on the opportunity to explain the distribution options table verbally to each clinician. The project team believed that neither the hospital implementation team nor the physicians had enough time to carefully read through all the documentation and understand the complexity of the routing system. Unfortunately, the team's experience in the pilot was that the planned verbal communication with physicians most often did not occur.

5.1.2 Intervention Setup

We started this first intervention by meeting with the entire project team. The project director introduced me to the team and outlined the opportunity to engage in this research. He explained that the purpose of the meeting was for the project team to reach agreement on if and how participating in the research would be beneficial to the project. The team members then elaborated on their challenges in getting time and attention with the physicians and hospital staff. They all agreed that they needed a different communication mechanism for the second pilot implementation and expressed their willingness to try a new approach. This led the team to define the following objective for this research intervention.

Intervention Objective: Improve the effectiveness of the lab result distribution service communication material for (a) hospital staff so that they understand the data they need to enter and (b) physicians so that they select the appropriate routing configuration that meets their needs.

The project team had a set of three swim lane diagrams they had developed for communication amongst themselves to depict the logic of the lab result distribution process. They liked the swim lane construct but felt their diagrams were too complex for the clinicians and hospital staff and did not cover the full scope of the change. Together we identified the following design objective.

Design Objective: Explore and refine two or three conceptual modeling methods for depicting the scope of change for a transformative technological healthcare initiative that highlights the process change for each stakeholder in a quick and easy to understand format.

We then formulated a plan for the intervention to iteratively and collaboratively design and construct two or three diagrams to depict the lab results distribution process. We identified a core design team of four people from the project plus me. This core design team was responsible for making design decisions regarding the diagrams. The core design team consisted of two practice advisors and the solution architect. The role of the practice advisors was to advise clinical practises on implementing the provincial EMR. They coordinated directly with clinicians and hospital administrations to plan and implement the change. They also developed communication material and performed some of the training. The role of the solution architect was responsible for designing the technical solution for integrating the EMR with the other clinical information systems in the health authorities.

The rest of the EMR project team were tasked to provide feedback on the design produced by the design team and provide input into the content of the diagrams. Our intervention activity plan consisted of iteratively meeting with various project members as they were available, gathering information, constructing the diagrams, reviewing these diagrams with other project members, and finalizing the diagram with the whole team. The project director also asked that I review the pilot lessons learned document, once it was completed by the project coordinator, and identify with her where the diagrams could be incorporated in the next pilot implementation to improve stakeholder communications. Figure 12 provides an overview of the research outputs and outcomes of this first intervention. Table 4, located at the end of this section, provides a

summary of the activities and design outputs which evolved as we progressed through the intervention.

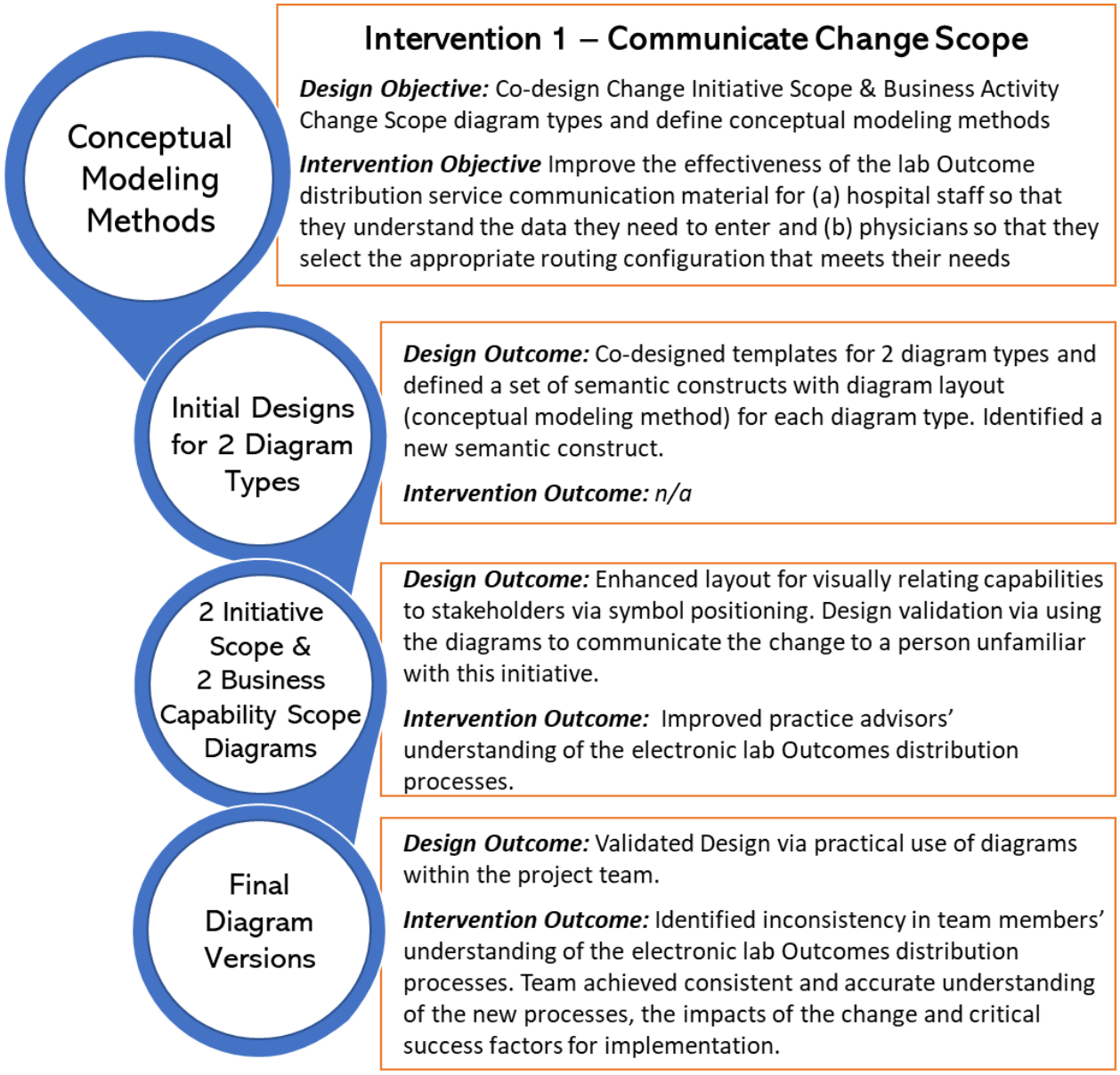


Figure 12 – Research Outputs and Outcomes of the First Intervention

5.1.3 Intervention Story

5.1.3.1 Defining the semantic scope of the first diagram type

Artifact design started with a meeting of the new appointed diagram design team and the project coordinator. The design team members provided an overview of the project to me and then described the biggest stakeholder engagement challenges they had faced in the pilot implementation.

The first challenge the team explained was getting the physicians to understand the lab result distribution options and select the right options to match their expectations. Many of the physicians worked at more than one clinic, including their own private practice, specialist clinics operated by the health authority as well as the emergency department in the local hospital (which at the onset of the pilot decided they would also implement the EMR rather than expand their use of the hospital information system). Some of the physicians had selected they wanted all lab results for any patient they saw and then were very annoyed when lab results from patients they saw in the emergency department clogged up their inbox in their private practice EMR. As the team discussed and reflected on this challenge, they identified that physicians did not fully understand the scope of the lab results distribution change initiative and the potential impacts on processes in their practices. This lack of understanding meant the physicians also did not grasp the scope of the implementation effort in their clinics. Many of the private practice clinicians felt this was just an IT project and delegated their medical office assistants to attend any information, planning and training sessions. Thus, when the physicians were required to select the lab result distribution options they wanted, many of them did not have enough contextual understanding to make a fully informed choice.

The design team determined they first needed one diagram that explained the scope for the new lab results distribution initiative. This diagram would provide the context for two additional diagrams that explained the overall set of processes for diagnostic test reporting and the set of processes for setting up report distribution for a clinician. I suggested it might also be useful to have a "Why Change" diagram that depicted the overall change drivers and the expected value for the stakeholders. However, the team felt this type of diagram would not provide any additional assistance to solving their two pressing stakeholder engagement challenges. They felt the existing textual value proposition in the registration package provided to physicians was easily understood. Their communication challenges were centred on articulating what was changing and what stakeholders needed to do to successfully implement the change. Thus, we determined to focus this intervention on constructing "What Changes" diagrams.

Before the design team decided on what constructs should comprise the first diagram type, we decided to explore their second significant challenge in case the same diagram type could help in this situation also. The second challenge was that the registration clerks in the hospital laboratory were not entering the right data to correctly route the lab results. Thus, even if the physician had selected the correct routing options, the lab results might still not arrive or might arrive in the wrong EMR. Because a physician could be attached to multiple clinics, it was essential for the registration clerk to enter in the lab system the identification number of the clinic on the lab requisition. This was a new piece of data that had not previously been provided on the lab requisition. In some cases, the registration clerk did not enter the clinic identification number, and in other cases the wrong number was entered. When the practice advisors investigated this problem, they found the hospital administrators had not informed the clerks about the new lab results distribution offering. The clerks had each individually made sense of

this new number that suddenly appeared on the requisition forms. One clerk just ignored the number because she did not know what it was. Another clerk saw the same number on many of the requisitions she received and decided to enter that number for all the requisitions that did not have a number. The hospital administrator had not informed the clerks about the new lab result distribution system because during their review of the textual documentation they had received they had not realized there was critical routing data the clerks needed to enter.

The design team felt that these top two communication challenges could be partially addressed by one diagram that depicted the scope of the change initiative if the contents identified:

a) all the stakeholders involved in the full diagnostic result process from creating and processing test requisitions to distributing and receiving lab results,
b) the outcomes for each stakeholder participating in the initiative,
c) the key new or changing business and clinical activities, and
d) the significant activities for each stakeholder in their journey to implement this change.

Each of the semantic constructs, that is stakeholder, outcome, and activity, identified by the design team were defined in the initial draft of the ontology. However, the design team wanted to clearly distinguish between a permanent business activity required for ongoing delivery of the change initiative and a temporary implementation activity required only during the scope of the project to implement the change. Given the challenges described above, the design team believed that clearly communicating the implementation activities for which each stakeholder was responsible was critical to the successful delivery of the offering.

The design team identified that a change implementation activity differed from a business activity because it was temporary and would no longer be performed once the change was implemented. Since a change implementation activity existed only within the span of a formal change implementation project or a less formal change implementation journey, it could be considered as a separate semantic construct to an ongoing business activity. Thus, we added "journey activity" to the ontology. The design team decided to use a rectangle with a light grey outline as the symbol for a change journey activity. They felt the sharp angles and lines of a rectangle reflected the precise definition of implementation activities which needed to be executed in the same way in every repeated implementation.

The team also wanted to use a different label for "business activity" because "business" was not a term commonly used in healthcare and could have negative connotations in public health care settings. They also wanted to emphasize the distinction between the one-time implementation activities and the ongoing business activities. We settled on the term "capability" which is a term commonly used in the enterprise architecture and business process management spaces to identify a combination of business assets, including business knowledge and processes, to accomplish an objective (Burlton, Ross and Zachman, 2017). This definition is very similar to the definition initially developed for "business activity." Although "capability" was also not commonly used in healthcare, the clinicians on the design team felt it would be more palatable to clinicians and hospital staff than the term "business activity."

5.1.3.2 Designing the semantic scope of the second diagram type

The second diagram focused on the scope of the diagnostic test reporting capability. The purpose of this diagram was to describe the processes, technology and information involved in this capability, which processes each stakeholder was involved in, and which stakeholder

behaviours were critical to successful execution of the capability. The design team baulked against the term “behaviour.” They each believed that clinicians would react negatively to any suggestion of behaviour changes. Since both clinicians on the design team personally disliked the term, we decided to explore using a different term. The practice advisors suggested they would be comfortable explaining to stakeholders what new and/or existing personal responsibilities were critical to successful execution of the new processes the stakeholders would be performing. I was not convinced that the term “responsibility” fully captured the meaning of the semantic construct. However, the other members of the design team were happy with the term. Thus, we settled on “responsibility,” with the intent to assess its suitability after the rest of the project team had been exposed to the diagrams.

Next, we discussed what symbol we should use for the “responsibility” construct as a symbol for this construct was not defined in the initial design of the grammar. One team member suggested we use a check mark icon, because checklists were a common protocol quality control tool. Although this was the same symbol used for “Outcome”, the rest of the team liked the suggestion and we decided to discuss this symbol overload issue at the next meeting.

The purpose of the third diagram was to describe the business activity to configure and implement the diagnostics results distribution service for a clinician. We decided this was an ongoing business activity and not a project implementation activity for two reasons. New clinicians may join the practice or clinic temporarily or permanently in the future and would need to be setup for their preferred results distribution. Clinicians may also want to modify their results distribution setup over time. The third diagram contained the same semantic constructs as the second diagram but with different content focused on a different business activity. Thus, we

determined the second and third diagrams were different instances, that should be generated by the same conceptual modeling method and therefore, follow the same layout.

5.1.3.3 Defining the Diagram Layouts

With the semantic constructs for the three diagrams determined, I than facilitated a discussion with the design team to develop the diagram layouts in accordance with the conceptual modeling methods described in chapter 3. Building on the A.1 guide, which specifies to list stakeholders vertically at the left of the page with related items placed in horizontal proximity, and building on the preference of the design team for the swim-lane construct in process diagrams, we decided to lay out the scope of the change initiative diagram in a tabular form consisting of four columns as depicted in Figure 13.

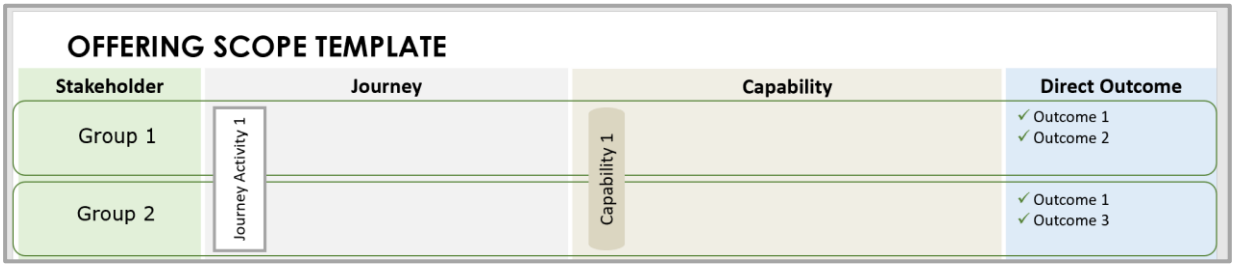


Figure 13 – First Draft of the Change initiative Scope Diagram Layout

Each column contained a set of instances of one of the semantic constructs. Following the A.5 guide each column was labeled with the name of the semantic construct. Following the A.2 and A.4 guides an instance of a semantic construct was placed in horizontal proximity to the stakeholder to which it was related. Where an instance of a semantic construct was related to more than one stakeholder its symbol was elongated across all the stakeholders to which it was related.

We determined the layout for the capability change scope diagrams (Figure 14) should follow a similar lane and column layout with stakeholders as the first column. We wanted to

maintain stakeholder-centric communication across all the diagrams. Using similar layouts across multiple diagram types would increase user familiarity with the diagrams and decrease the cognitive effort to learn and decipher additional types of diagrams.

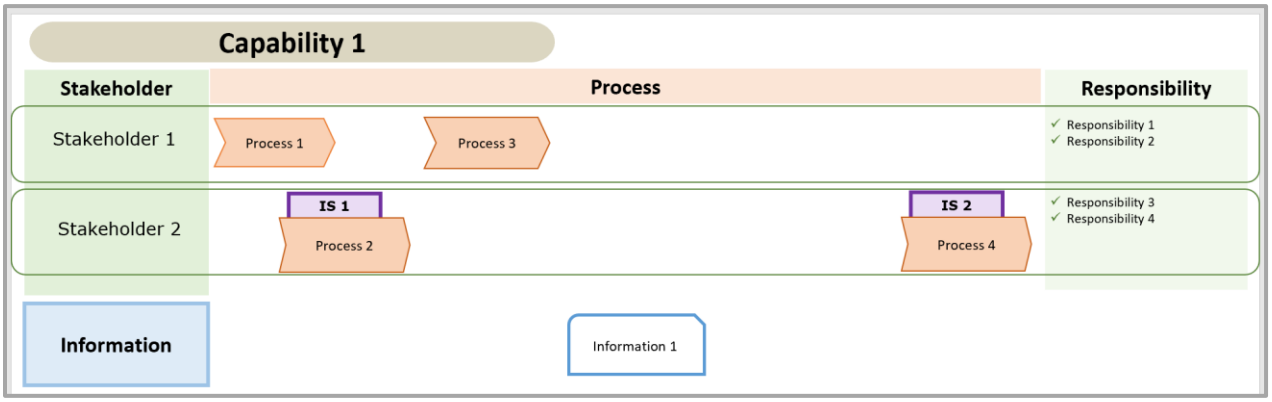


Figure 14 - First Draft of the Business Activity Scope Diagram Layout

The middle column depicts the processes executed within the capability. Like the journey activity and capability constructs on the first diagram type, the process construct can be elongated across multiple stakeholders where more than one stakeholder is involved in the same process. We used left-to-right horizontal proximity to indicate the general order of process flow. The third column identifies the crucial responsibilities assigned to each stakeholder. A final row was added below the stakeholder lanes to depict the types of information pertinent to the changes in the capability. Again, we deployed dual coding and also labeled the construct types, except for the information technology construct.

Because this was an information technology driven change the team wanted to explicitly depict which processes used which information technology systems. To accomplish this, we needed to violate the one of the design principles (A.8) we had defined in our top-level conceptual modeling method. This design principle specifies an instance of a semantic construct should only be depicted once. However, we wanted to visually attach information technology

symbols to each applicable process, but we were limited to two dimensions. Since the column was being used to depict processes and the rows depicted stakeholders, we could not use a row or column to depict information systems. This meant we had to duplicate the information technology instance next to each process in which it was involved. Because we were using column and row headers to label constructs and we did not have information systems symbols all in the same row or column we could not easily label the construct type. However, since there was a small number of different information systems and their names were well known to the stakeholders, we thought it likely they would be easily recognizable as information systems without explicitly identifying them as such. Thus, we decided to forego dual coding the information technology construct and assess if any stakeholders were confused as to what type of construct the information technology symbols represented.

5.1.3.4 Building the diagrams and revising the design

Armed with these decisions from the design team and equipped with documentation that described the diagnostic test result distribution system, I constructed a very rough draft of the three diagrams using the initial definition of the conceptual modeling grammar.

I returned to the design team with these rough drafts for the team to review and expand. I also had many questions which were not clearly answered in the documentation provided. As the team discussed, revised, and added to the diagrams the two practice advisors realized that they also did not fully understand the results distribution logic. Even though the practice advisors had read the technical documentation, attended presentations from the technical solution architect and written documentation for the clinics, when confronted with representing the scope and flow in a diagram they were either unsure or had a contradictory understanding to each other. We continued the discussion on how to update the diagram to reflect the results distribution

processes accurately and clearly until the practice advisors agreed on how these processes worked.

Out of this discussion we determined the processes for diagnostic test reporting varied depending on whether the diagnostic test was ordered while the patient was in hospital or was ordered by the primary care physician in a clinic during a visit with the patient. Since this variation in process impacted what options a physician might want to select for receiving results, we decided to explore creating two instances of the diagnostic result reporting capability, one for the common route of reporting diagnostic tests ordered in a private clinic or private practice and one for distribution of any type of clinical report generated within an acute care facility, including the results of diagnostic tests.

The practice advisors also expressed their opinion that the program management and project leadership did not fully understand the complexity of the implementation journey for the lab results distribution business activity. It appeared to them that management saw results distribution as a simple add-on to the larger EMR implementation initiative. They felt that this resulted in an oversimplification of the preparation activities and an underestimation of the extent of stakeholder engagement required for the implementation to be successful. They believed this had been manifested in the very tight timelines for the pilot implementation, insufficient effort in communication and the resulting confusion experienced by all involved. They wanted a better way to communicate the extent of the change journey to management. To highlight the difference between the general EMR project and the lab results distribution project, we decided to create another instance of the change initiative diagram type, to describe the scope of the general EMR offering.

Due to the ongoing activities of the EMR project the design team had limited time allocated to complete the first design of the diagram types. The design team had little interest in discussing a unique symbol for the "responsibility" semantic construct and at this point other duties were claiming their attention. Although depicting two different semantic constructs with the same symbol violated one the PoN principles, we decided to leave it as was, and note any indications of confusion that may occur during the construction and use of these diagrams in subsequent meetings.

Two weeks later, I returned to the design team with drafts of the two new diagrams and the modifications to the first two diagrams as discussed in the previous meeting. The team also invited the person responsible for external stakeholder communications in the overall EMR project to join in the review and discussion. The communications person commented that this was the first time she had been to any meeting about distributing the results of diagnostic tests and knew nothing about it. However, with a brief explanation of the diagrams from one of the practice advisors she was able to participate in the discussion and offer useful ideas for re-titling some of the capabilities, processes and stakeholders to be more intuitive to clinicians and other people outside the project team.

During this meeting, we also discussed two design changes to the diagram layouts. On one of the change initiative scope diagrams we had encountered the situation where a capability involved multiple stakeholders, but one of these stakeholders was not adjacent to the other stakeholders. This meant we could not elongate the capability shape across all the stakeholders because the shape would cross two stakeholders that were not part of this capability. We considered rearranging the order of the stakeholders to resolve this challenge. However, it was critical that patients remain at the top of the list of stakeholders to reinforce the health

organization's focus on being patient centric and this made it impossible to rearrange the stakeholders so that they were adjacent for all shared capability involvement. I suggested we

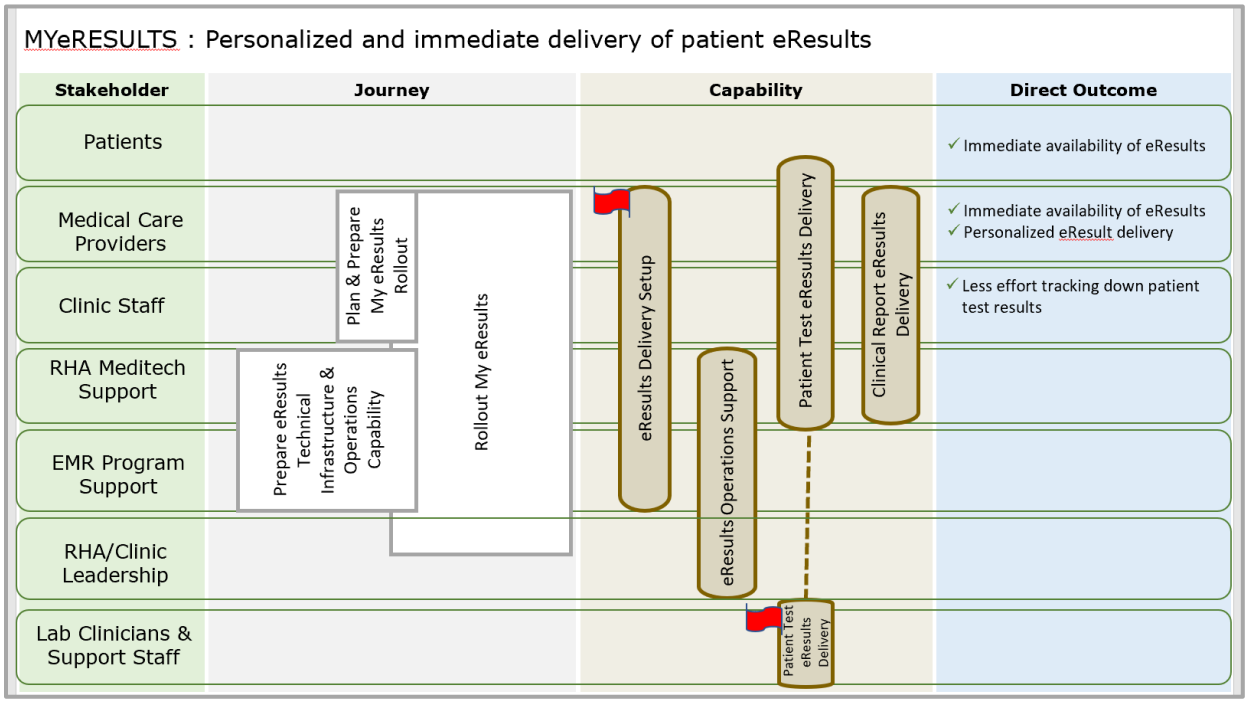


Figure 15 - Sample Results Distribution Change Initiative Scope

split the shape into two segments connected with a dotted line with the capability title in the top section as shown in Figure 15. A couple of the team members wondered whether that was intuitive enough for people to instinctively understand it was the same capability. The team decided the title should be duplicated in all segments but in smaller font, if necessary, to make the title fit in the smaller segments.

One of the practice advisors wanted to put a red flag on the two capabilities that had encountered the most misunderstanding and problems during the pilot project. She felt that the red flags would highlight the importance of the respective stakeholders understanding these capabilities. I suggested these flags might be extraneous as they did not represent a specific construct. The practice advisor countered that the red flag meant "to take note" or "pay

attention." None of the other members on the design team had an opinion for or against this idea, thus we decided to leave the flags and observe how the rest of the team responded to them. These new designs decisions are portrayed in Figure 16, which depicts the scope of the change to automatically deliver patient eResults to the appropriate clinicians in their respective EMR systems.

The lead practice advisor and I met one more time to review and revise the content of the diagrams. During this meeting we identified two outstanding questions about how the reports distribution service would work more generally for other patient reports generated within the hospital, such as discharge summaries. The practice advisors had assumed that acute care reports distribution would work in exactly the same way as lab results generated during a patient's stay in hospital. However, as we worked through building the diagram for the general clinical report distribution business activity, the practice advisor realized it could not work the same way. She suspected that no one on the team had considered this and identified at least two solution design questions that she could not answer.

During this final review meeting we had a lengthy discussion on how much detail to include or leave out in these diagrams. The discussion started with the practice advisor wanting to add substantially more detail in the change journey activities and the capability processes. As described in a previous section, guided emergence is the principle for the reflection and learning stage of ADR. I deliberatively implemented this principle during this discussion with the practice advisor by first explaining the theory of cognitive load. We discussed how increasing the level of detail would increase the number of activities and processes depicted on the diagrams and thus increase the cognitive load for the diagram readers.

We then considered if this increased load was intrinsic or extraneous since our goal was to reduce extraneous load as much as possible. We used the PoN principle of cognitive fit to assess whether the additional detail was intrinsic by determining if the detail was essential to the purpose of the diagram and responded to the needs of the audience. As we talked through this, the practice advisor came to the conclusion that although the additional detail might be useful for a step by step procedure definition or training guide, it was not necessary to (a) promote understanding of what was changing to an audience already familiar with the existing process; and (b) highlight to each stakeholder the key individual responsibilities they would need to change or implement. We further reflected on how this additional detail could thus incur extraneous cognitive load for the clinicians and hospital staff and so be a distraction. This led us to propose that the PoN principle of cognitive fit be applied not only to the design of the semantic constructs and modeling method, but also to the scope of the contents of the diagram. We added application of the PoN principle of cognitive fit to the diagram contents as a general guide for all the modeling methods.

5.1.3.5 Finalizing the diagrams with the whole team

Two months after I was introduced to the EMR team, the entire team met again. At this meeting, the lead practice advisor presented the completed diagrams and led the discussion. I did not play an active role but focused on observing participant actions and documenting the discussion. This meeting was the first time the program manager, project manager and privacy expert had seen the diagrams. The practice advisor started the presentation with the change initiative scope diagrams and followed with the business activity scope diagrams. She presented the general EMR change initiative scope (Figure 16) on the presentation screen and walked through the contents. She also provided printed copies of each diagram to everyone in the

meeting. Everyone focused on their printed copy as she talked. The only comment on this diagram came from the project director. He asked the team to consider which diagrams would be applicable to large or small clinics and to consider creating a standard package that could be left with the clinics by the practice advisors after their first meeting.

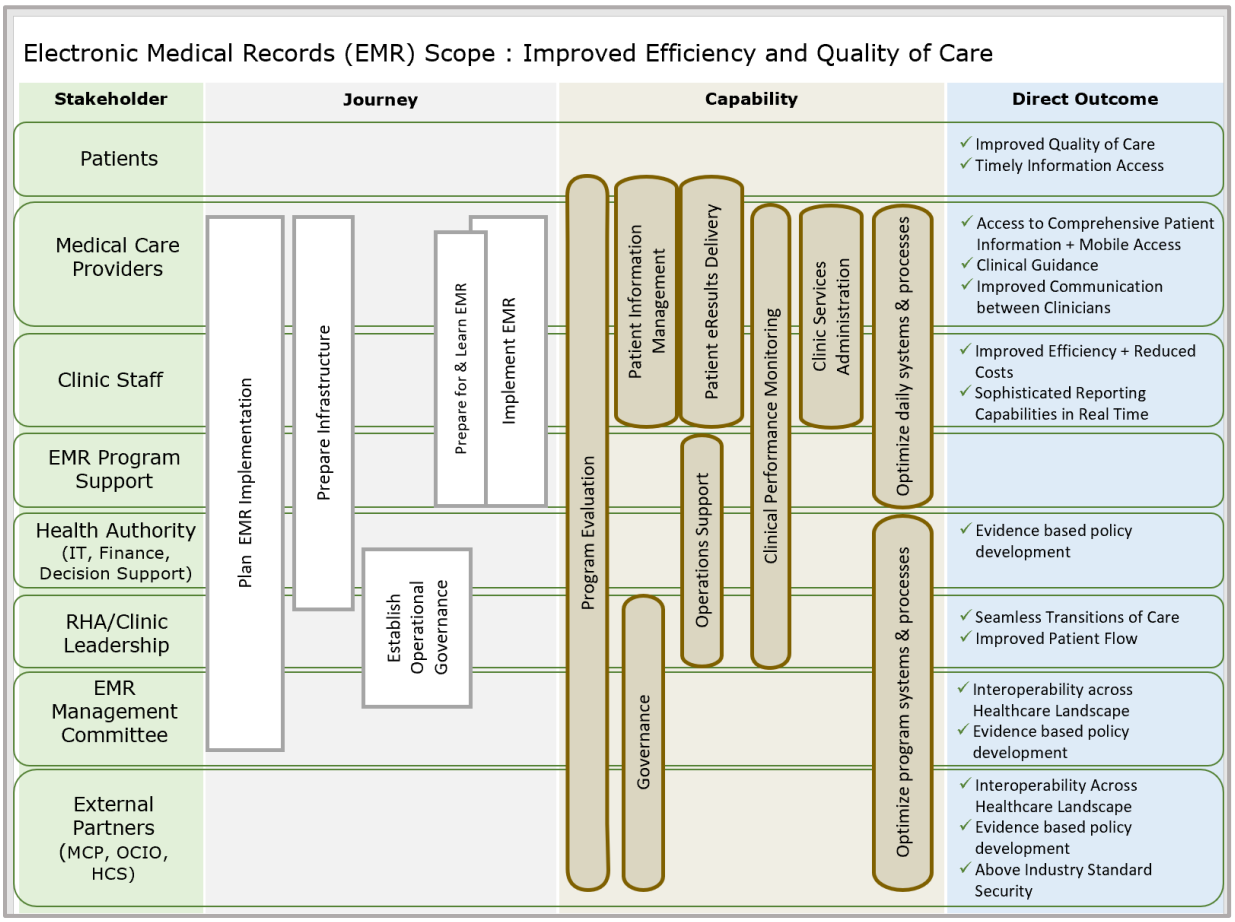


Figure 16 - EMR change initiative scope

The practice advisor moved on to the results distribution change initiative scope diagram (Figure 17). There was some discussion on this diagram focused on the content text and the team decided on a new title for Diagnostic Test Reporting capability to better reflect its broader scope of any type of patient result, including discharge summaries. The title they agreed on was "Patient eResults Delivery." One of the team members asked what the red flags meant. The

practice advisor explained she had placed red flags on the two capabilities to draw attention to the importance of these capabilities. However, different team members then expressed how they had interpreted those flags differently and nobody had understood the flags to mean that it was important for the respective stakeholders to understand the red flagged capabilities. The team unanimously voted the flags were extraneous and should be removed.

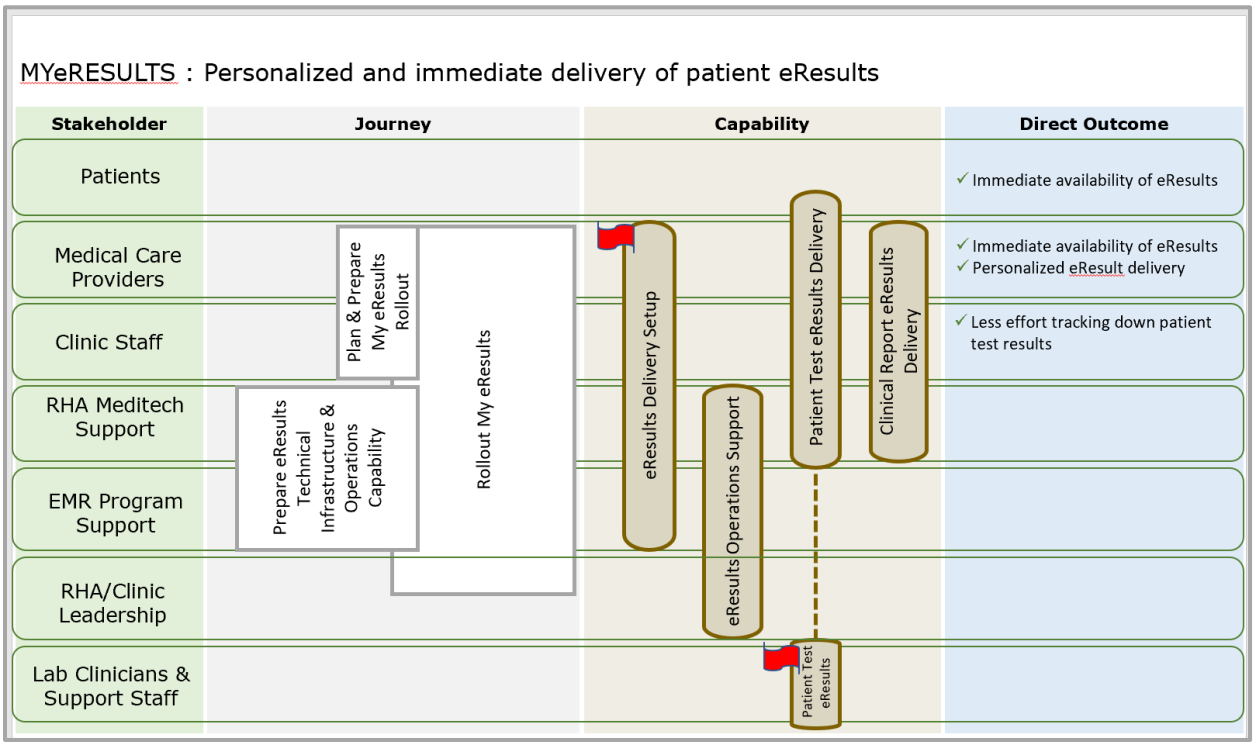


Figure 17 - eResults Change Initiative Scope

Next, the practice advisor presented the eResults Delivery Setup business activity scope diagram (Figure 18). There was a lot more discussion on this diagram and many questions about the processes depicted on the diagram. The program manager had not previously realized the extent of the processes and stakeholders involved in this business activity. She asked specific questions about why certain processes were necessary or what their purpose was. The practice advisor was able to answer all her questions and direct the program manager's attention to related processes and information on the diagram. None of the team members, except the two

practice advisors had realized the level of complexity of setting up the eResults distribution configuration and the amount of cooperation needed across stakeholders to complete the configuration and to maintain it as locums (physicians temporarily helping or backfilling for other physicians) came and went.

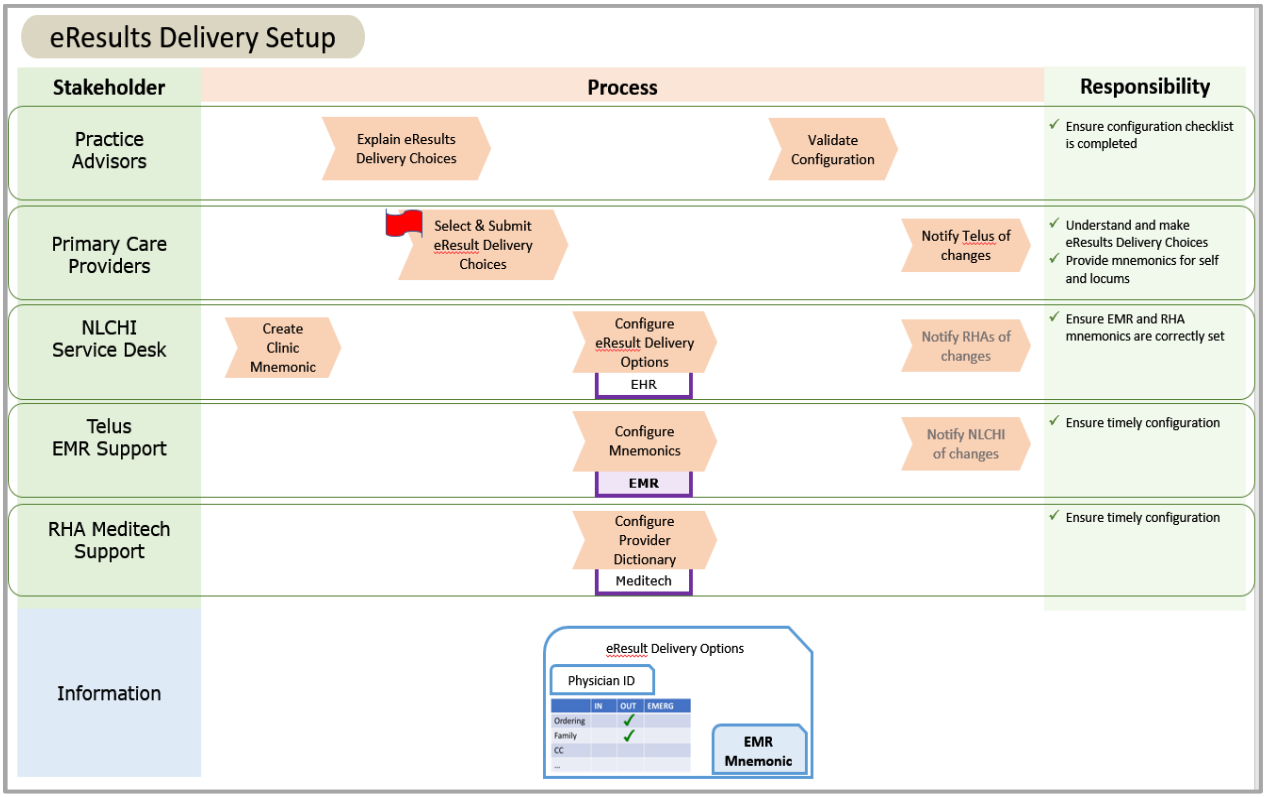


Figure 18 - eResults Delivery Setup Business Activity Scope

The final diagram (Figure 19) presented by the practice advisor was the Patient Test eResults Delivery business activity scope. Again, there were several questions from the program manager and other team members about processes they had not realized were essential. The program manager almost immediately asked why the lab registration clerks were identified on the diagram as she thought nothing was changing for them. She assumed they would still be entering information from the lab requisition into the same hospital system as they had previously done.

The practice lead explained that the EMR identifier was a new piece of data for the lab clerks to enter. The EMR identifier had not previously existed on the requisition form. She explained that entering this number correctly was critical to the lab test result being routed to the right EMR used by the physician. This turned into an "Aha!" moment for the team and explained why the lab clerks had not been informed of this new and critical step. The program manager had propagated her lack of understanding on to the health authority administrator who then did not realize there was any impact on the lab clerk. The practice advisors had not realized the program manager did not have the full picture and discovered this was why they had not been able to understand why the lab clerks did not know what to do. No one had read the details buried in the project documentation that explained this small but critical task for the lab clerks. During this discussion, the team agreed on changes to some of the process names to further clarify the purpose and critical actions of these processes.

As with the first diagram no one felt the red flags were intuitive on any of the diagrams and were distracting because they were trying to figure out what they meant. The team were all in agreement for the removal of the red flags from all the diagrams. This decision by the team reinforced the PoN principle of semiotic clarity whereby all symbols should have a one to one match with an ontological concept. The intervention ended with me updating the diagrams to reflect the content input provided by the team members in the final meeting and removing the red flags. These diagrams were provided back to the practice managers to include in the next implementation pilot. Unfortunately, various circumstances delayed the next implementation by over a year. This delay, together with the departure of the lead practice advisor and a change in project leadership, prevented the opportunity to assess the effectiveness of the diagrams to communicate the scope of the change with clinicians and hospital administrators.

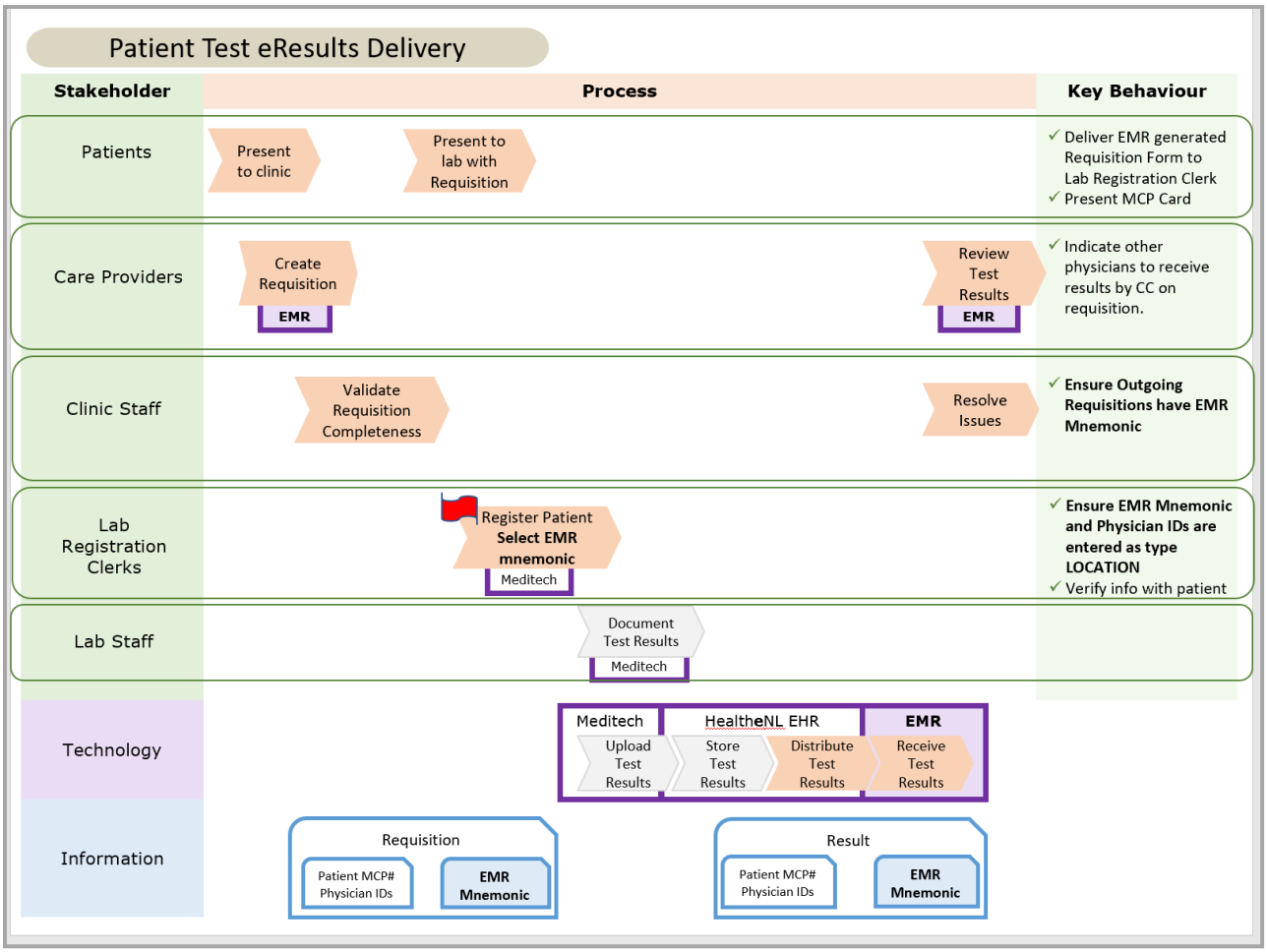


Figure 19 - Patient Test eResults Delivery Business Activity Scope

Table 4 summarizes the activities and outputs and/or outcomes that comprised this first intervention.

Table 4 - Activity Summary of Intervention One

Who	Activity	Outputs / Outcomes
Clinical VP	In person meeting to discuss the research opportunity	Positive assessment of potential value of the research to some of the organization's change projects.
Program Director	In person meeting to discuss the research opportunity	Positive assessment of potential value of the research to a new service offering.

Who	Activity	Outputs / Outcomes
		Implementation project and appropriate fit of the project with the general problem space.
Program Director + project team (9 members) + researcher	In person team meeting to introduce the team & research	Intervention objective and design objective.
Core design team (4 members + researcher)	In person meeting to determine the purpose & scope of potential diagrams	One new semantic construct. Revised labels for two semantic constructs. Two modeling methods with defined sets of semantic constructs. Decision to build on swim lane layout.
Researcher	Review project documentation and draft diagrams.	Three draft diagrams.
Core design team	In person meeting to review and enhance draft diagrams.	Content enhancements. Improved practice advisors' understanding of the results distribution processes.
Core design team + Comms person	In person meeting to review and enhance diagrams. Test the effectiveness of the diagrams with a communications expert	Design enhancement for visually relating capabilities to stakeholders. Design enhancement for highlighting critical capabilities A fourth draft diagram. Content enhancements.
1 member of core design team + privacy expert + researcher	In person meeting to review and enhance diagrams. Test the effectiveness of the diagrams with someone familiar with the project.	Design guideline for scope of content in each modeling method. Content enhancements. Solution design questions for acute care reports distribution.

Who	Activity	Outputs / Outcomes
Project team + researcher	In person meeting to present and review the diagrams. Test the effectiveness of the diagrams with other project members.	Content enhancements. Design enhancement to remove notation to highlight critical capabilities. Identified and addressed understanding gaps and inconsistencies across the project team regarding the scope of the change.

5.1.4 Summary of Design Findings

5.1.4.1 Diagram Type Utility and Efficacy

The intervention ended unexpectedly due to an unforeseen external situation and change in leadership and we were not able to proceed to determine if we achieved the original intervention objective. This meant we could not evaluate the utility and efficacy of the diagrams against this objective. However, the team recognized that using a conceptual modeling approach to depict the scope of change had surfaced gaps and inconsistencies in the project team's understanding of the change that no one realized existed. This demonstrated unexpected utility of the language. Creating and using the diagrams had enabled the project team to rectify their own knowledge deficiencies and reach a common understanding in a short period of time. This demonstrated the efficacy of the diagrams in improving clarity of communication on the scope of change, although not for the originally intended purpose.

We did, however, achieve the original design objective. We designed two types of diagrams for scoping change using a stakeholder centric perspective. One diagram type could be used to describe the scope of the change initiative, including the impacted business activities (a.k.a. capabilities), and significant change journey activities required to implement the change.

The second diagram type could be used to identify the processes, technology and other resources that would change within a business activity. In developing these two diagram types, we had applied and tested the ontology and the conceptual modeling grammar. We refined the ontology and conceptual modeling grammar and further developed the conceptual modeling methods as summarized in the following sections.

5.1.4.2 Ontology Design Changes

We added another relationship to the concept of "goal." Although we had initially identified that an "outcome", a sub-type of "goal" is influenced by "perception" which is in turn "held" by a stakeholder, this was not reflected on the diagrams. During the intervention we did not specifically identify stakeholder perceptions, but we did identify direct outcomes for each stakeholder. Therefore, the ontology should not require "perceptions" to be explicitly defined to link an outcome to a stakeholder. Thus, we added a new direct relationship between "goal" and "stakeholder."

5.1.4.3 Conceptual Modeling Grammar Design Changes

We added a new semantic construct to depict the activities in the journey to implement the change. We defined "capability" as an alias for business activity. We also defined "responsibility" as an alias for "behaviour" but with the expectation that this alias be revisited and other aliases considered in the next intervention. We still had the issue with the symbol for "behaviour" being the same as the symbol for "goal" and thus violating the PoN principle of semiotic clarity. During the final meeting with the entire project team, no one remarked on these two symbols being the same and no confusion was observed directly by me or indirectly through the questions asked and comments made by the team members.

The lack of semiotic clarity may have had little impact due to several reasons. Goals, in the form of direct outcomes, and responsibilities did not occur on the same diagram so the duplicate symbol for these two constructs may not have been noticed. The background shading for direct outcomes was different from the background shading for responsibilities and each set of instances of these semantic constructs were clearly labeled with the name of the semantic construct. Thus, dual coding and different colours may have reduced the impact of lack of semiotic clarity created by duplicate symbols. However, this reduction of impact may not be as strong if both semantic constructs were to be depicted on the same diagram. This design issue was considered again in the next intervention.

Ontology Modifications

Concept	**GOAL**
Definition	Declarative statement of intent to achieve a desired state of affairs.
New and Modified Relationships	*Desired by* STAKEHOLDER (0..n) *Influenced by* PERCEPTION (0..n)
Rationale	Enables diagrams to depict direct outcomes for specific stakeholders without requiring explicit definition of a perception held by the stakeholder. Not all goals will be related to specific stakeholders, for example organization outcomes and capability performance goals. The same outcome or design requirement may be desired by multiple stakeholders.

Concept	**STAKEHOLDER**
Definition	An organization, group or individual affected by the change.
New Relationship	*Desires* GOAL (0..n)

Rationale	Enables diagrams to depict direct outcomes for specific stakeholders without requiring explicit definition of a perception held by the stakeholder. Some stakeholders may not benefit from the change and therefore there may not be a goal defined that they desire, for example suppliers that will no longer be used. A stakeholder may desire multiple outcomes or design requirements.

New Concept	**CHANGE JOURNEY ACTIVITY**
New Definition	An activity or set of activities to be undertaken during a change implementation project or during any temporal and bounded journey to implement change.
New Relationships	*Impacts* Stakeholder (1..n) *Establishes* Business Activity (1..n) We did not investigate any relationships with other concepts.
Rationale	This concept and the definition arose out of the need to describe the various temporal activities stakeholders would engage in as part of the change initiative to establish the new or modified business activity.

Visual Semantic Modifications

Change Journey Activity Symbol	
	***Rationale:*** Rectangles are very commonly used in work break down structure diagrams created by project managers. Therefore, using a rectangle would be familiar to the diagram users. We chose light grey so that the symbol would visually blend in with the pastel colour scheme of the diagram.

Behaviour (a.k.a. Responsibility) Symbol	
	***Rationale:*** Protocol quality control checklists are a common tool in healthcare. Behaviour or responsibility change is often related to service quality improvements. Thus, some of the intervention participants suggested, the check mark would be a familiar icon to health care workers and create a positive connotation for the purpose of the behaviour/responsibility change.

5.1.4.4 Conceptual Modeling Methods Design Changes

During this intervention, we substantially developed conceptual modeling methods for two "What Changes" diagram types. The conceptual modeling method labeled TA.1 in Table 5 below defines the layout and guidelines for depicting the overall scope of the intended change and the high-level change implementation activities for a change initiative that includes multiple business capabilities or services. The method labeled TB.1 in Table 5 defines the layout and guidelines for depicting the scope of change for a specific business activity or service, including the processes and resources.

In addition, we tested and refined the common modeling method labeled A. We discovered that we need a mechanism to elongate a symbol, such as a capability across non-adjacent stakeholder lanes as it was not always possible to arrange stakeholders contiguously for all shared capabilities. We found that there were exceptions to principle A.9 which states that an instance of a semantic construct should only appear once on a diagram. For example, some intended direct outcomes were the same for multiple stakeholders. Since we were using small icons with long labels to portray these outcomes, we could not visually elongate these symbols

across multiple stakeholder lanes. Therefore, we needed to repeat these common outcomes in each stakeholder lane to identify the beneficiary stakeholders. In addition, we needed to indicate which technology a process used. Since, several processes used the same technology, the same technology instance was depicted multiple times attached to multiple processes.

We demonstrated that dual coding was not always necessary. We could not label technology constructs with one instance of a label because each technology instance was attached to a process and did not directly occur in on column. The lack of a label for the information technology semantic construct did not appear to cause any confusion. When the diagram containing this construct was presented to project members for the first time, they did not ask any questions or make any comments that indicated they did not know what this symbol represented. Even when explicitly asked by the practice advisor presenting the diagrams if there was anything that was not clear, no one mentioned the information technology constructs. Since a number of these same people did ask what the red flags meant and disputed why certain stakeholders and processes were included on the diagram, we inferred that everyone understood the instances of the information technology semantic constructs. This intuitive understanding was likely because this was an information technology project, and everyone was familiar with the names of the three information technology systems. Since the technology constructs were labelled with the names of the information technology systems, these constructs could be instantly recognized as instances of information technology.

We also determined that the principle of cognitive fit can be applied to scope of detail depicted on the diagram as well as the scope of the concepts. Specifying this principle can help participants decide to eliminate information that will contribute to increased extraneous cognitive

load without improving comprehension per the purpose of the diagram. These additions and modifications to the modeling methods are described and justified in Table 3 below.

Table 5 - Conceptual Modeling Method Enhancements in Intervention One

ID	Method Principle	Rationale
A.9	An instance of a semantic construct should only be shown once on the diagram unless additional useful meaning is communicated by showing the instance multiple times, such as its relationship with instances of other semantic constructs.	It some cases it is not possible to show a construct's relationships with multiple instances of another construct and avoid the use of lines (A.2). Repeating the visual depicting of a construct instance in physical proximity to the related construct can be less cognitively complex than a myriad of lines.
A.10	A semantic construct symbolized by a shape may be vertically elongated across multiple stakeholders to depict a shared relationship with all these stakeholders. Where the stakeholders are not vertically contiguous, the shape may be depicted multiple times in vertical alignment with a dotted line connecting each instance. Each instance should contain the title of the instance. The font size of any smaller shapes may be reduced to fit within the shape.	When it is important to indicate multiple stakeholders are involved in the same occurrence of a process or activity, elongation of the shape can be used. This provides visual distinction from multiple stakeholders each involved in different occurrences of the process or activity. However, it is not always possible to arrange the stakeholder symbols contiguously for every shared process. The dotted connecting line and smaller font provide a visual distinction from unconnected duplicated instances. This violates A.1 avoidance of lines, but no

ID	Method Principle	Rationale
		other solution was identified in this intervention.
A.11	The principle of cognitive fit with regards to the audience and purpose of the diagram should be applied to the contents of the diagrams. The scope of instances of semantic constructs, should be limited to that which is essential to the purpose of the diagram.	Any additional detail that does not contribute to the purpose of the diagram for the intended audiences increases extraneous cognitive load.
TA.1	Instances of the following semantic constructs should occur on a diagram to explain the high-level scope of a change initiative: Stakeholder, Change Journey Activity, Business Activity (a.k.a. Capability), Direct Outcome	Per the PoN principle of Complexity Management, creating a hierarchy of diagrams enables each diagram to have a focused purpose with only the information required for that purpose. The purpose of this diagram type is to depict the scope of the change initiative, that is who is involved, what are the overall intended outcomes for each stakeholder group, what business capabilities are impacted and how is the work to implement the change organized.

ID	Method Principle	Rationale
TB.1	Instances of the following semantic constructs should occur on a diagram to explain the scope of change to a specific business activity: Business Activity (a.k.a. Capability, single instance only), Stakeholder, Process, Technology, Behaviour (a.k.a. Responsibility), Information.	Per the PoN principle of Complexity Management, creating a hierarchy of diagrams enables each diagram to have a focused purpose with only the information required for that purpose. The purpose of this diagram type is to depict scope of change to one business activity. This includes who is impacted by this specific change and how their behaviour / responsibilities need to change, the direct outcomes (if any) of this specific change to each stakeholder group, and the impacted processes and other resources.

The next intervention built upon the design enhancements developed in this intervention. We also planned to resolve the issue of the duplicate symbols for "behaviour" and "outcome."

5.2 Intervention 2: Refining Change Scope

5.2.1 Intervention Background

In the second research setting we adapted the Change Initiative Scope modeling method and diagram type to achieve a slightly different purpose. We also expanded the Service Change Scope modeling method and diagram type to include more concepts and concept relationships. A provincial health authority had engaged two consultants to facilitate framing a standardized model for the in-patient care service provided in two rural hospitals and to develop a business

case for funding the design and implementation of this new model in both hospitals. Both the existing two models were fractured and had become logistically and financially unsustainable. There was strong agreement across the clinical and administrative stakeholders on the need to develop a new model that eliminated clinical provider silos and was patient centric and initial work on framing the new model had commenced. However, the consultants were experiencing a substantial roadblock in gaining the time and attention of these stakeholders to finalize the model and complete the business case.

The stakeholders had participated in focus groups led by the two consultants and identified challenges and potential changes to the in-patient care service. The two consultants had written a two-page summary of the identified challenges, researched best practices and the team's recommendations for what needed to change. The consultants had distributed the document to all the stakeholders in the team for their review and further input. Despite repeated reminders, not a single team member had responded to the consultants with comments or questions. Subsequent attempts to schedule meetings were either ignored or met with repeated requests to delay the meeting. A few team members that did respond indicated they had not yet found enough time in their demanding schedules to thoughtfully review the material.

One of the consultants, who was a colleague of mine, approached me to discover if it might be possible to create a diagram or two depicting the suggested scope of change and see if this would be successful in soliciting feedback from these busy project members. Since this situation appeared to meet the first and third criteria for prospective interventions, I asked if the project team would be willing to engage with me as a research project. My colleague was very willing, but approval to participate in the research would need to be obtained from the project steering committee. To improve the chance of approval, we decided to work together to draft one or two

diagrams, which my colleague could present to the steering committee along with a research brief.

5.2.2 Intervention Setup

The following week I met with my colleague and the other consultant for a morning to discuss their progress on developing the business case to-date and the stakeholder engagement challenges they were encountering. Out of this discussion we defined the following intervention objective.

Intervention Objective: Overcome the current stakeholder engagement blockage, gain feedback and agreement on the proposed scope of change from the project participants and approval from the steering committee.

We then reflected on the potential constraints hindering the project participants from providing feedback to the consultants. We discussed theories of communication and cognitive load and noted that all the project participants had demanding jobs with a heavy cognitive load, significant responsibility for the lives of others, constant situations requiring urgent attention and often worked overtime. Both consultants expressed that they needed to engage with the project participants in a way that was more effective and more efficient then reviewing a written document. We agreed that they would need diagrams designed specifically to (a) reduce cognitive load and (b) be easily understood with minimal explanation. The consultants looked through the diagrams produced in the first intervention and suggested that the change initiative scope diagram type and the business activity scope diagram type might be suitable for their purposes. We ended this discussion by defining a design objective similar to that of the first intervention.

Design Objective: Adapt and test the two diagram types developed in the first intervention to depict the scope of service change in a quick and easy to understand format.

It was not practical in this intervention to use precisely defined measures for this design objective. Therefore, we identified indirect measures. We defined "quick and easy to understand" as able to read and comprehend the diagram after a brief one to two-minute verbal explanation and provide useful feedback in twenty minutes or less, having never seen the diagram before. We defined "useful feedback" as (a) content clarifications that improved stakeholder understanding of the purpose, scope or impacts of the change and (b) provision of missing content that impacted the scope of the change.

We concluded the first meeting by formulating a research intervention plan to present to the steering committee, that would involve minimal effort on the part of the project participants. The consultants then worked with me to draft the two diagrams and we presented these, along with the research plan to the steering committee. After approval from the steering committee, the consultants and I met with each project participant individually for 10 to 30 minutes to obtain their feedback on the proposed scope of change using the diagrams to facilitate the discussion. Project participants were not required to read anything in advance of the meetings. We advised the participants that if they found the diagrams confusing or otherwise felt unable to provide what they deemed as sufficient feedback, the meeting could be terminated and other avenues for feedback could be explored at a later date. The intervention concluded with an audio recorded, semi-structured interview with the consultants. They reflected on their experience using the visual language to develop the diagrams and on the achievement of the intervention objective. Figure 20 provides an overview of the research outputs and outcomes of this first intervention.

Table 6 at the end of the next section provides a summary of the activities that occurred during this intervention.

Figure 20 - Research Outputs and Outcomes of the Second Intervention

5.2.3 Intervention Story

5.2.3.1 Adapting the diagram types

During the first meeting when I reviewed the diagram examples with the two consultants, they raised one potential design change to the change initiative scope diagram type. They were not convinced that depicting the journey activities was useful in their situation because they believed agreement on the implementation plan had been reached. They wanted to focus the conversation on ensuring agreement on the scope of the change and how change success would be evaluated. They had both experienced challenges in nailing down how to measure the achievement of the expected outcomes in this initiative and in previous healthcare change initiatives. They wanted to facilitate additional conversation and reach agreement across the project participants regarding the specific indicators for the inpatient care service that would be measured to track the success of the change. To inform their decision on this design change we agreed to develop two different drafts of the change initiative scope model, one with the journey activities as per the existing diagram type and one without the journey activities but including indicators and the source of the data for measuring the indicators.

After the first meeting, I spent a couple of days drafting the diagrams applying the two modeling methods that were developed in the first intervention and using the two-page document as the content source. This document was written clearly and packed with information. It took me about two hours to read through it the first time and identify the contents for each of the diagrams. Several more hours were then required to ascertain how the various pieces of the content related to different stakeholders and to each other. During this document analysis, I identified a few inconsistencies and questions that I was unable to resolve. I also found numerous

gaps in the identified direct outcomes, indicators, and stakeholder responsibilities. I noted all these for discussion in the next meeting with the consultants.

5.2.3.2 Drafting the diagrams and continuing design modifications

The following week the two consultants and I met for half a day to review and refine the diagram drafts and decide on which layout to use for the change initiative scope diagram. Both the consultants immediately selected the revised version which depicted indicators to measure the direct outcomes and did not include the journey activities. We decided not to merge the two versions and thus not include the journey activities for two reasons. First, the consultants did not need to have further conversation on the journey activities. Second, the consultants wanted the diagram to fit on a standard letter size page and still be readable. Thus, the journey activities would be extraneous to the consultant's purpose for the diagram and all the other important content would need to be reduced in size making it more difficult to read.

The second design decision we made was to shade the "Direct Outcome" vertical column the same green as the "Stakeholder" column instead of shading it blue. The reason for this was to emphasize that this change would deliver direct outcomes for stakeholders, not just operational outcomes for the organization, and that each of these depicted outcomes were directed towards specific stakeholders. The green shading also matched the green colour of the checkmark icon used to identify each outcome.

I had only inserted a few indicators in the draft as only a few were perceivable in the document. One of the consultants had already listed a set of indicators prior to the meeting. We went through the list and mapped each one to the stakeholder direct outcomes. As the consultants thought of additional indicators during the discussion, we also mapped these against the direct outcomes. Where no applicable outcome existed, we either defined additional outcomes, or did

not include the suggested indicator. In this way we were able to objectively assess and ensure the usefulness of each indicator.

We then discussed whether we needed to visually link each indicator with the corresponding direct outcome it would measure. We decided not to depict a visual link for several reasons. In some cases, we had only identified a general set of indicators and these mapped to multiple direct outcomes. For example, "provider experience measures" was a general set of indicators that would be used to measure different outcomes for different clinical stakeholders. This set of indicators did not need further definition until the scope of change had been approved and so would remain general for the current purpose of the diagram.

There were also some direct outcomes that could be measured by a combination of indicators, for example, "Improved work-life balance" could be evaluated by a combination of provider scheduling data and provider experience measures. Visually depicting many-to-many relationships would be quite messy, increasing cognitive load with no anticipated additional value to the discussion of change scope. Instead, to prompt discussion on missing indicators or missing direct outcomes, we inserted an indicator symbol labeled with a "?" as shown in Figure 21.

Next on our agenda was to discuss any design changes to the business activity scope diagram, which depicted the scope of change for providing inpatient care. There was a substantial amount of change to this business activity and the consultants want to visually highlight that most of the processes needed to change. They also wanted to distinguish between resources that needed to be changed and resources that needed to be included in providing inpatient care, where perhaps they were not consistently included before, but did not need any change to the resource itself. We decided to use background shading of the symbol to depict this.

Any process or resource that would undergo structural change was shaded a lighter colour of the outline of its symbol. Any process or resource that did not require any internal structural change was not shaded, that is, its symbol was filled with a white background. As can be seen in Figure 14, the only two processes not expected to change in inpatient care are “Admit to Facility” and “Leave Facility” and there is no anticipated change to any of the technology.

We then discussed the use of the label "Responsibility" versus "Behaviour.” One of the consultants was also a nurse and her immediate response was that "Behaviour" would not be a palatable term although behaviour change was a key construct they wanted to depict. However, neither of the consultants were happy with the term "Responsibility" either. They felt it did not clearly portray that these were significant behaviour changes that were necessary for the change to be successful in moving from provider centric to patient centric care and achieving the direct outcomes for the stakeholders. After much discussion, the consultants both agreed on the label "Key Expectations.” I suggested that "expectation" was ambiguous because expectations could exist for things other than behaviour. However, the consultants felt that the term "expectation" set the tone that these were important and essential and that stakeholders would infer from the titles of the construct instances that these were expectations of ways of working and interacting with each other.

As determined in the previous section, I raised the issue of needing different symbols for "direct outcomes" and "key expectations.” The consultants liked the checkmark for both semantic constructs. Implementing patient and staff safety programs was a strong focus for hospitals in Canada and all hospital staff and clinicians in these two rural hospitals were familiar with checklists of things that needed to be performed and achieved. The consultants were happy with the checkmark icon, they did not think it would cause confusion and were not interested in

pursuing the conversation further. Therefore, this symbol duplication was left unresolved for the time being.

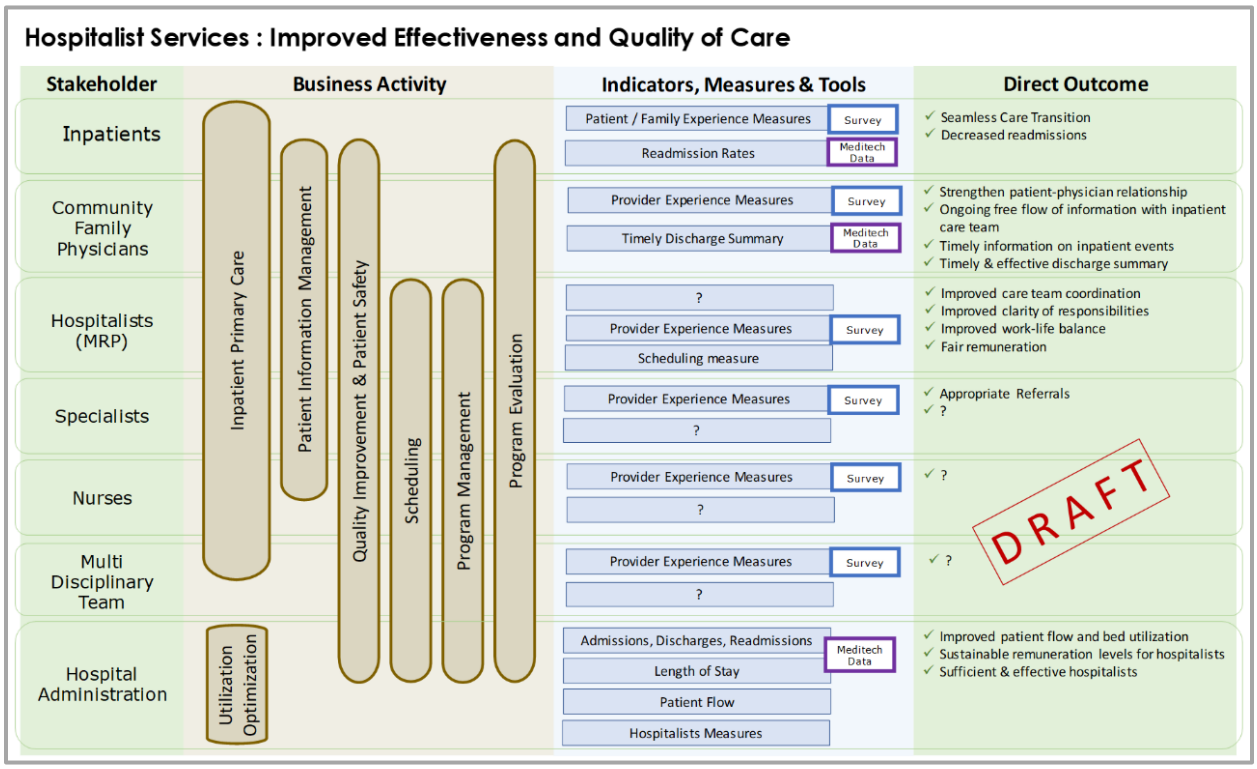


Figure 21 - Draft of the Hospitalist Services Program Change Scope Diagram

From this conversation the consultants did identify "Quality improvement & patient safety" as an additional business activity that would be impacted by this change. This is the business activity that would monitor the indicators and evaluate the ongoing achievement of the direct outcomes. We made a few additional changes to the content labels to better align with the terminology used in the organization and then moved on to the second diagram.

The second diagram depicted the scope of change for the Inpatient Primary Care business activity and followed the conceptual modeling method for business activity scope developed in the first intervention. The only design change we made to this method was to also include the semantic construct "Guidelines" at the bottom of the diagram as shown in Figure 22. There were

several agreements, policies, practise standards and other guidelines that were underdevelopment or had recently been created or enhanced which would impact the design of the processes contained in this business activity.

As we worked through the Inpatient Primary Care business activity change scope diagram, the consultants discovered that there were still a few areas where they were not clear or had different understandings. In the words of one of the consultants "the process of working through that tweaking [of the diagram] helped us … to crystalize in our minds what it was that we needed to be able to convey." For example, issues with follow up care after discharge were cited in the summary document as within the scope of change. Thus, in the initial draft of this diagram, I had placed follow up care as the final process in the Inpatient Primary Care business activity after the patient is discharged. Doing this did not make sense because once a patient is discharged from the hospital, the inpatient primary care business activity has ended. It only took a few minutes for the consultants to remark on this incongruency. This led to them discussing their notes and jointly realizing the real issue was lack of timely communication with the family physician such as the common delay in the process of communicating the discharge summary. We removed the follow up care process from the diagram and the final process in the business activity became "Create and communicate discharge summary."

The consultants sent the diagrams depicted in Figure 21 and Figure 22 along with the research brief to the project steering committee and received unanimous approval at the following steering committee meeting to use the diagrams to engage the rest of the project team in providing feedback as well as permission for me to observe and document the project participant engagement sessions. A four-day trip was planned to the two cities in which the hospitals were located, and meetings were arranged with all the project participants. Each project

participant was informed of the research project via email and sent a copy of the one -page research brief. They were also reassured that they did not need to read the previously provided summary document before the meeting. All project participants, except for one who was out of town, accepted the meeting invitation. The consultants felt encouraged that the first stage of the intervention objective was achieved. The stakeholder engagement blockage had been overcome and each stakeholder was willing to meet with them.

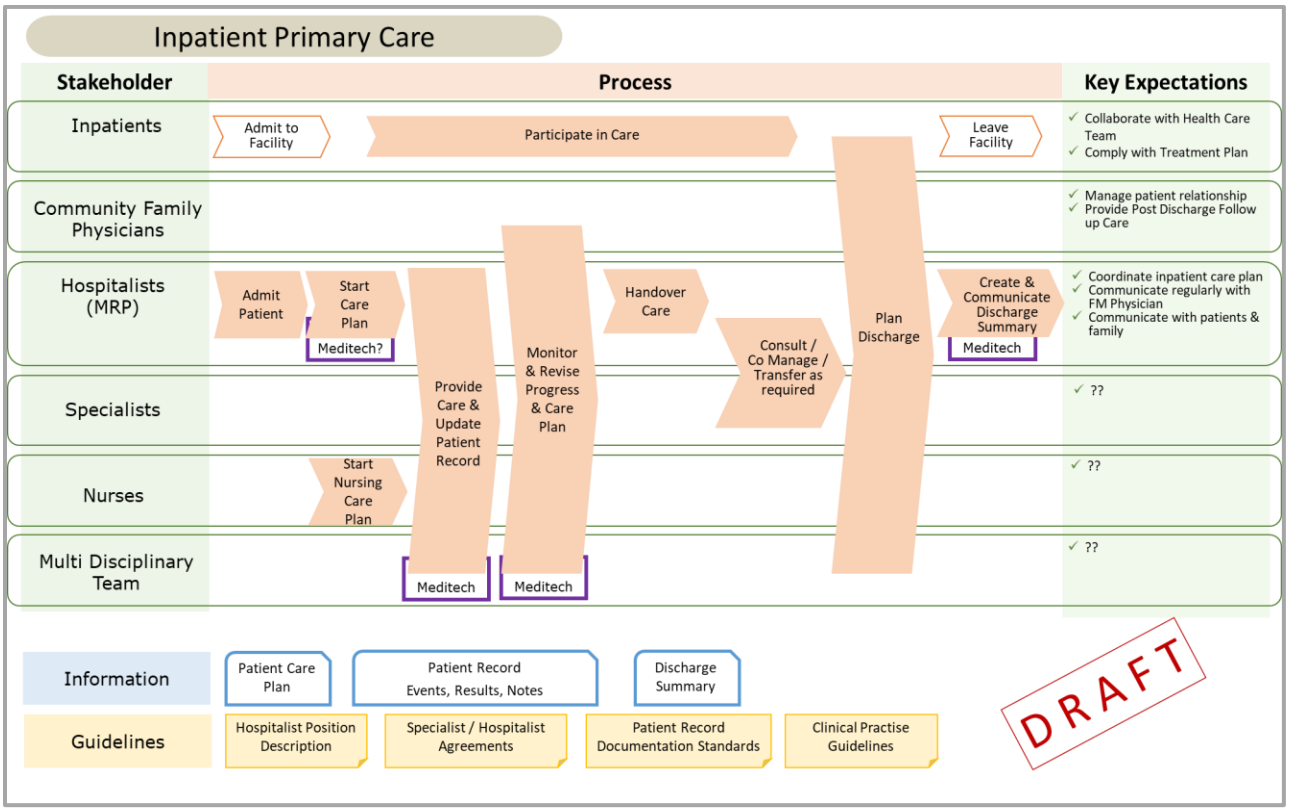


Figure 22 - Draft Inpatient Primary Care Business Activity Change Scope Diagram

5.2.3.3 Using the diagrams to engage the team and expand the content

Over the course of four days, we met with nine project participants and the multi-disciplinary team administrator. The latter person had not been involved in the original project focus group meetings and the regional administrator had requested an opportunity for this person to review the change scope and provide input as a representative of the multi-disciplinary team

stakeholder group. The management consultant started each meeting by introducing me as the researcher and providing a printed copy of the research brief. Each participant then gave verbal consent to my presence and note taking during the meeting.

The management consultant then explained that it appeared project participants found the written description of the changes to the inpatient primary care service took too long to read and we were now trying a visual depiction to discover if it is quicker and easier for them to read. The clinical consultant then provided a printed copy of each diagram to the participant and gave a thirty to sixty second explanation of the diagrams. She described the purpose of each diagram, reading and pointing to the semantic construct labels as the top of each of the columns. The consultants then asked if what was shown on the diagrams was correct and if anything was missing.

All participants provided some feedback and most of them also asked questions about the content. Participants were also asked for their input in areas where we had placed question marks to indicate more information was needed. At the end of the meeting each participant was asked for their reaction or comments on the diagram format if they had not already expressed an opinion.

To protect the privacy of the participants, we used a three-character code to identify each participant. These identifying codes are used throughout the remainder of this chapter to refer to specific individuals.

Our first meeting was with the regional administrator (RA1) who oversaw delivery of health care services and the multi-disciplinary team administrator (MTA) who oversaw the services provided by health care providers who were not physicians or nurses, for example

physiotherapists, occupation therapists, psychologists, speech therapists, and social workers. Since the multi-disciplinary administrator had not been involved in any of project meetings discussing the scope of change and therefore was unfamiliar with the scope of the change, we were particularly interested in her reaction to the diagrams and whether the content would be intuitive to her. The management consultant began by asking if the right stakeholders were shown. Both participants looked at the diagrams in their hand and RA1 asked for clarification on who was included in "Community Family Physician." There was a short discussion and agreement that in some cases in one of the hospitals the same person could fulfill role of the Community Family Physician and Hospitalist. RA1 then asked if the "Multi-disciplinary Team" included community health staff as well as hospital staff. The management consultant confirmed that it did. MTA then interjected that the health information system used by community health services was not depicted on the diagram, only the hospital information system was shown. During her explanation of the diagram, the consultant had not mentioned the technology symbol and this semantic construct was not labeled on the diagram. This comment by MTA was an indication that she had intuitively identified the technology semantic construct because of her familiarity with the name of the hospital information system.

RA1 then remarked that "Discharge Planning" was shown at the end of the processes, but it needs to start right at admission and will be woven throughout the entire inpatient primary care service. She also stated that the Discharge Planning process must include the community health services information system so that physicians know what home supports the patient is receiving. There was more conversation with both participants on the topic of integration with community health services and the critical impact it had on enabling a patient centric case management perspective for timely discharge and seamless follow up care.

The conversation then turned to the second diagram and both participants provided input to identify additional indicators and data sources relevant to the stakeholder groups they represented. MTA then interjected again, asking if her assumption was correct that if something crosses multiple stakeholders then it means that all those stakeholders are involved. The clinical consultant confirmed the assumption was correct. MTA then remarked that the Utilization capability should cross every stakeholder. She stated that there needed to be a move to include all stakeholders in taking responsibility for efficient utilization of hospital services and this would require sharing of utilization data with everyone, including patients and family.

Our next meeting was with the administrator of one of the hospitals (HA1) in her office. Despite being constantly interrupted by the phone throughout our fifteen-minute meeting, she was still able to review the diagrams and provide input. The first interruption occurred halfway through the introduction where she was asked for a decision on another operational project she was leading. After the management consultant concluded the introduction, HA1 looked intently at the Inpatient Primary Care diagram for about a minute without saying a word. The clinical consultant asked her if all the stakeholders were shown. HA1 replied that family should be included with the Patient stakeholder since many families are involved in making decisions about patient care. In between each interruption, HA1 returned to look at the diagrams and the consultants systematically directed her attention to each area where they want confirmation or input from her. HA1 asked questions, provided input on clarifying the content and suggested new instances of key expectations, guidelines, indicators, and data sources.

The third meeting was with a hospitalist (DR1) in a small meeting room in the hospital. We only had about five minutes to discuss the diagrams with him before he was called away. However, in that time he focused on three processes depicted on the diagram that he believed

needed to change to have the most positive impact on the way hospitalists worked. He quickly explained how these processes were currently performed, what was wrong and how he thought they should be implemented to be more patient centric. He only had a minute to look at the change initiative scope diagram, but he did remark that this diagram would be useful to use with his care team as a reminder of the desired outcomes and to track progress on the indicators.

The remaining five meetings followed a similar pattern to the ones described above. We met with four more physicians, the regional administrator responsible for physician recruitment and retention, and the hospital administrator of the other hospital. In each meeting the contents of the diagrams were confirmed, refined, and/or expanded. The program change scope diagram received the most input from stakeholders in management positions. This diagram was initially quite sparse, but, by the end of the meetings, outcomes with indicators had been defined for all stakeholders, as shown in Figure 23. The consultants remarked that in discussions prior to these meetings, it had been difficult to focus conversation on outcomes. But, upon looking at the change initiative scope diagram, people seemed to naturally gravitate to filling in the blank spaces most related to themselves.

Our meetings occurred in six locations in two different cities. The travel time between meetings afforded the consultants and me the opportunity to reflect on and discuss the effectiveness of the diagrams in obtaining input from the project participants and augment the notes I had taken. In the evenings and on the trip home we discussed and determined how to apply the received input to the diagrams.

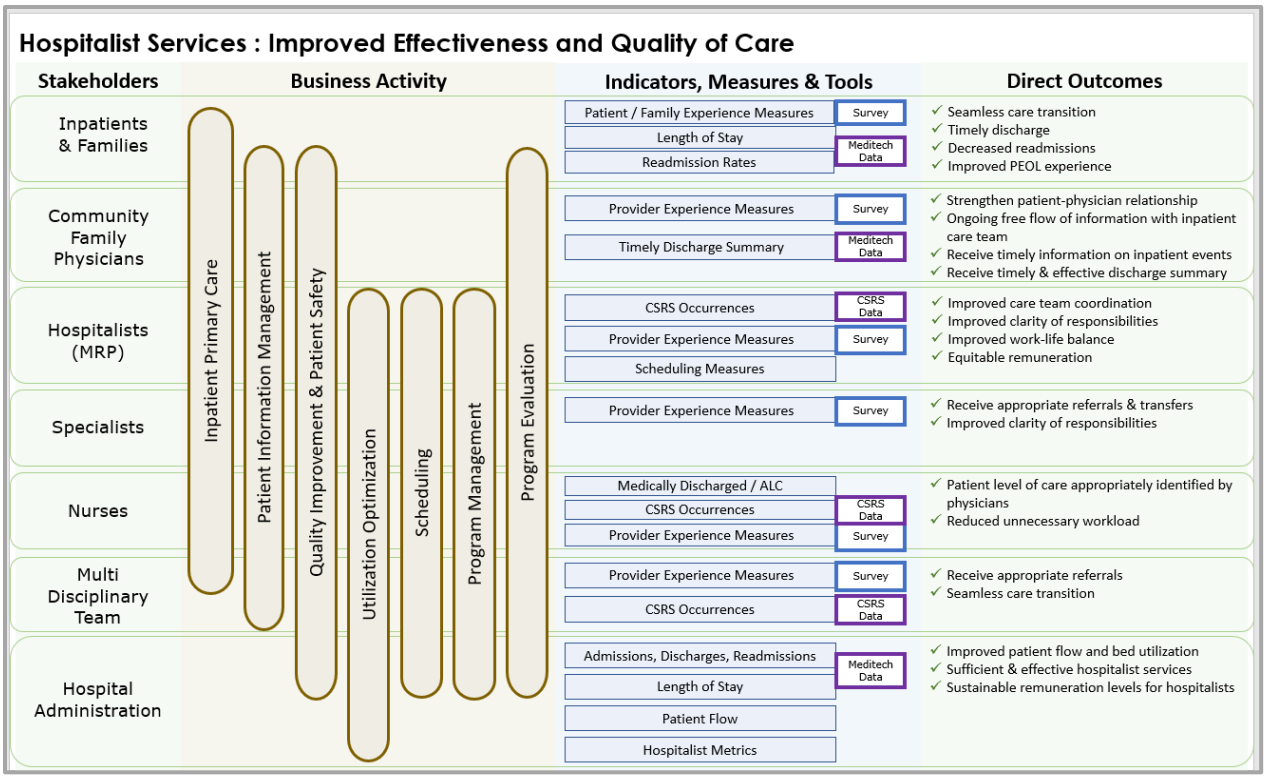


Figure 23 - Final Hospitalist Services Change Scope Diagram

The one design challenge we had was how to visually depict the "Plan Discharge" process as starting near the beginning of the set of processes, continuing throughout, and still having a set amount of work prior to patient discharge. Two other processes were also continuous throughout the provision of inpatient primary care, "Provide Care & Update Patient Record" and "Monitor & Revise Progress & Care Plan." The diagram was not meant to depict a detailed process flow and we had shown these processes in the order in which they started. Two additional processes were not continuous but could occur more than once at any point in the provision of inpatient care.

No one asked why these processes ended early or were not shown as repeating and no one appeared to show obvious confusion about the spatial layout of these four processes. We had not shown these additional process flow attributes on the diagram because the purpose of the

diagram was not to depict detailed process flow but to identify the major processes, and to indicate a general order of which ones happened at the beginning, the middle and the end of the provision of the inpatient primary care service. We first considered moving the "Plan Discharge" symbol from the end (far right) of the set of process symbols to the beginning (far left). This would be consistent with the layout of the other continuous processes which were positioned generally in the order in which the process started.

However, the "Plan Discharge" process had received the most attention in the meetings and was clearly a pain point that required change. Not only did this process need to start upon admission of the patient, but the multi-disciplinary team needed to be involved at various points to arrange home supports and other follow up care for many patients, and family doctors needed to be involved so that they could arrange space in their schedules to see the patient at the appropriate time after discharge, sometimes within a day or two. Identifying that there were multiple points in the process where various stakeholders needed to be involved was a critical aspect of depicting the scope of change because currently these stakeholders were not involved until the end of the process, if at all.

We did not want to extend the "Plan Discharge" symbol from the left side to the right side of the process column, because then the "Plan Discharge" symbol would cover most of the diagram and could give the impression that the other processes were contained within it, meaning that these other processes were sub processes. We explored showing the Plan Discharge process symbol once at the left of the set of processes and again at the right, just before the final process to create the discharge summary. We then added a dotted line with an arrow between the two symbols to represent continued activity as shown in Figure 24.

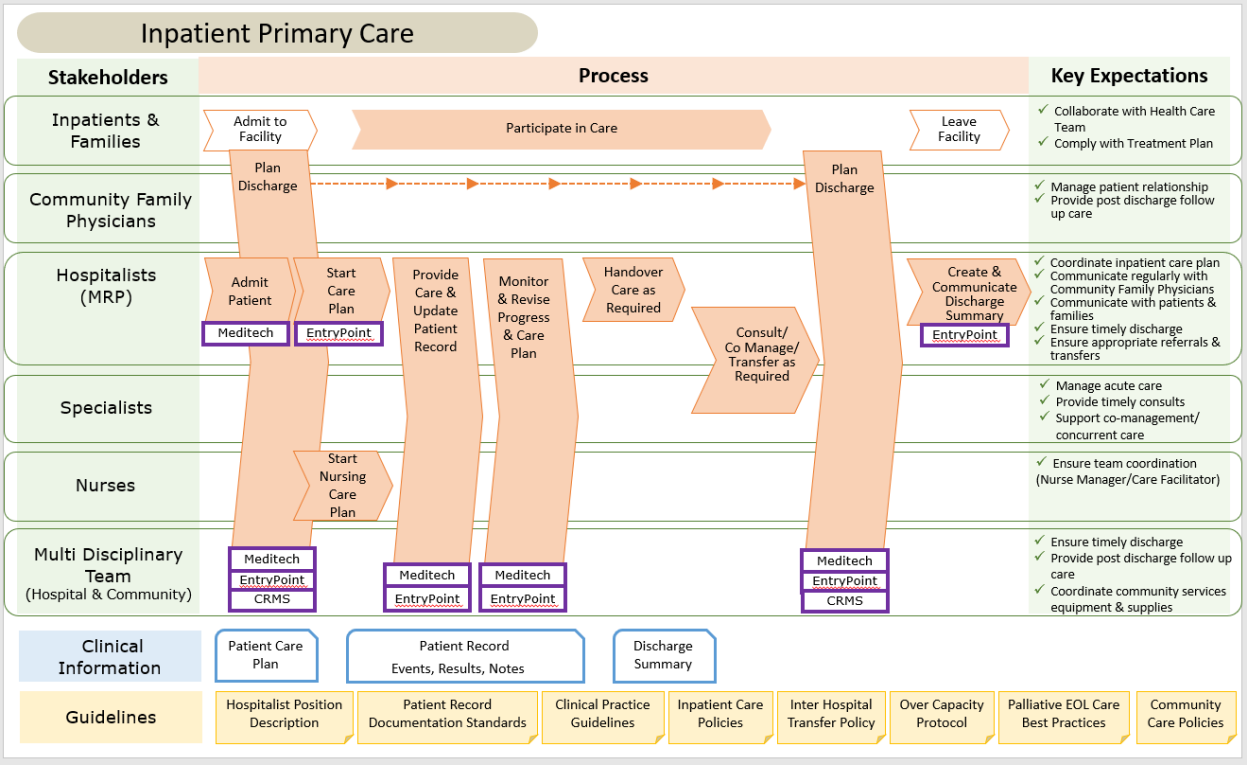


Figure 24 - Final Inpatient Primacy Care Change Scope Diagram

The clinical consultant was quite happy with this visual representation. Therefore, we decided to use this design in the final version sent back to the steering committee and monitor their reaction.

5.2.3.4 Finalizing the diagrams and reaching agreement on the scope of change

The project steering committee met three weeks later and were provided electronic copies of the final version of the two change scope diagrams. The two consultants attended the meeting, and the clinical consultant took notes of her observations and of comments made by steering committee members. Of the six steering committee members, five had participated in the research intervention meetings with us to review the diagrams and provide input and feedback. Only the steering committee chair had not been involved in these meetings. The management consultant handed out printed copies of the diagrams to the committee members and gave a brief

overview of the diagrams. Everyone around the table intently reviewed the two diagrams for about a minute and then started to offer their comments. The consensus was that each person felt their input had been reflected in the final version and felt comfortable that the scope of change depicted in the diagrams captured all the essentials. The steering committee granted approval to the consultants to complete the business case to take forward to government and decided to include the diagrams in the business case package.

Table 6 summarizes the activities and outputs and/or outcomes that comprised this second intervention.

Table 6 - Activity Summary of Intervention Two

Who	**Activity**	**Outputs / Outcomes**
Health Project Consultants	In person meeting to discuss the research opportunity and identify the research scope	Intervention objective and design objective. Selection of two modeling methods from the previous study.
Researcher	Review project documentation and draft two diagrams	First draft of change initiative scope diagram First draft of in-patient care service change scope diagram draft.
Health Project Consultants & Researcher	In person meeting to review and refine the two diagrams and plan the research activities	Enhanced consultants' understanding of the scope of the change. Design change to the initiative scope diagram Revisions to content of both diagrams

Who	Activity	Outputs / Outcomes
Health Project Consultants & Project Steering Committee	Teleconference to discuss the research opportunity	Unanimous approval for the project to participate in the research opportunity.
Health Project Consultants, Researcher & individual Project Participants	Eight meetings with individual members of the project team using the two diagrams to gain feedback on the proposed scope of the change.	Revised and additional content for both diagrams. Project stakeholders comfortable with the extent and quality of the depicted scope of change.
Health Project Consultants & Researcher	Review input provided by project team members and reflect on the eight meetings	Final versions of the two diagrams.
Health Project Consultants & Project Steering Committee	Review diagrams and agree on the scope of change.	Consensus and sign-off on the scope of change.
Health Project Consultants & Researcher	In person, audio recorded, semi-structured interview with each consultant.	

5.2.4 Summary of Design Findings

5.2.4.1 Diagram Type Utility and Efficacy

The intervention objective can be decomposed into several parts that reflect the efficacy and utility of the diagrams generated from the conceptual modeling methods. The first desired outcome was overcoming the stakeholder engagement blockage by gaining agreement from each project participant to meet. Not requiring participants to review any documents beforehand and booking short meetings enabled the consultants to meet with all project participants, except for

one who was travelling. The reassurance that all that was required of each participant was their input on two diagrams, not confirmation of the scope of change, may have also been a factor that promoted participant willingness to meet.

The second intended outcome was to generate diagrams that were quick and easy to read. This outcome was expected to set the stage for the third desired outcome which was to gain feedback from the project participants on the proposed scope of change. We defined four indicators to evaluate the efficacy of the diagrams for these two outcomes. We coded sentences in the observations notes from the participant meetings for these indicators and totalled the occurrences of applicable positive, negative, or neutral values of these indicators as described Table 7.

Table 7 - Efficacy Indicators and Evaluation

Indicator	**Evaluation Summary**
Initial comprehension difficulty	2 participants stated they were experiencing some initial difficulty in understanding the diagrams after the quick explanation and each required extra explanation and time to understand the diagrams.
Stated reaction to the diagrams at the end of the meeting	7 participants and the Steering Committee chair stated a clearly positive reaction to the diagrams using terms such as “like”, “love”, “flows well”, “quite good”, “will show this to my team.” 2 participants stated a neutral reaction. One said the “questions” caused the diagram to appear busy. Another responded that it could be a little bit overwhelming and she had to read it over. 1 team member stated she was not a visual person, but the diagrams would be good for others who were visually oriented.

Indicator	Evaluation Summary
Asked pertinent questions	6 participants asked pertinent questions about the diagram including why something was labelled, or appeared in, a certain way or why it was included in scope.
Provided valuable input	All 10 participants provided some level of valuable input, including identifying missing elements in the change scope and renaming or realigning elements for greater clarity. 8 participants provided valuable input on the scope of service change. 5 participants provided valuable input on the program change benefits model.

Overall, the project participants found the diagrams quick and easy to read. Although two participants required an extra explanation beyond the standard two-minute description provided by the clinical consultant, and one participant took longer to read the diagrams before providing feedback, this still only amounted to an extra two to three minutes. Even though one participant stated she was not a visual person, she still read the diagrams and provided feedback in less than twenty minutes, as did all the other participants.

The utility of the diagrams was demonstrated in that all the participants provided valuable feedback to correct or clarify the diagram contents and many of them provided additional information. The final change initiative scope diagram contained 65 instances of semantic constructs. Fifteen (23%) of those instances were added by the project participants during the meetings and five (7%) were modified. The final business activity scope diagram for inpatient primary care contained sixty instances of semantic constructs. Twenty-seven (45%) of those

instances were added by the project participants and five (8%) were modified. The five participants on the steering committee were able to confirm their own feedback and input had been reflected in the diagrams and review, discuss, and confirm agreement on all the additions and revisions in less than ten minutes.

This content analysis was compared against the reflections of the two consultants recorded during their final interviews and the coded results were found to be consistent with the consultants' reflections. Both consultants remarked on the positive efficacy of the diagrams in engaging the participants to read the information, provide feedback and reach agreement on the scope. One consultant reflected in her final interview that "it's hard without going through section by section [of a textual document] and facilitating some discussion, asking some questions, to get people to respond and give you the feedback you are looking for. However, with these diagrams it always impressed me the feedback that came from people around the room. And depending on the stakeholder and their perspective, I mean they zeroed in on things probably more specific to their area of work. But altogether it really was a great way to facilitate the discussion."

The other consultant reflected on the speed of the steering committee review of the diagrams "When we pulled it [the diagrams] out the chair said, 'I have heard a lot of great things about these diagrams.' And Dr B looked at them and … he could see that the input that he had provided in our meeting with him … that his comments were reflected. And he said 'wow, this is just exactly, this is it.' Again, not exactly those words but … we wouldn't hesitate to send that [the diagrams] out now."

In addition, the process of developing the diagrams using the conceptual modeling methods illuminated a couple of areas where the consultants were not clear and enabled them to reach

clarity and agreement. This clarified scope was confirmed by project participants. The consultants also used the diagram to keep their discussion focused on the items pertinent to defining the scope and consistently stopped each other from going down detailed rabbit holes in the conversation by reminding each other to focus on what needed to be portrayed on the diagrams. Another unexpected utility of the diagrams was discovered by the physician who was responsible for developing the policy framework for the standardized hospitalist services. He had commented at the beginning of our meeting with him that he had an idea of what policies needed to be written "but until I can see a picture of the model, I cannot finalize the policy for how it will function. I can't know where the gaps are." After reviewing the two diagrams he returned to discuss the policy development and concluded the discussion by saying "now we have something visual here I can see what policies are needed and where are the gaps. Now I have a model [for writing the policies]."

5.2.4.2 Conceptual Modeling Grammar Design Changes

In achieving the intervention objective, we also achieved the first part of the design objective, which was to test the conceptual modeling grammar and methods we had adapted. We successfully used the modeling grammar and modeling methods to generate two diagrams that were quickly understood by ten people with clinical or administrative professional skills. We identified a new concept, "Measurement Tool" and defined a new corresponding semantic construct in the modeling grammar. We decided to use a rectangle with a dark blue outline for the "Measurement Tool" symbol since a measurement tool is used to collect data for an indicator and the symbol for "Indicator" was a rectangle with a dark blue outline and shaded light blue. Our reason was that using a similar blue colour provides a visual clue to the tight relationship between these two semantic constructs.

Ontology Modifications

New Concept	**MEASUREMENT TOOL**
New Definition	A tool or data source for collecting data to assess the value or level of an indicator, for example surveys or information systems.
New Relationships	*Enables* Indicator (1-n) We did not investigate any relationships with other concepts.
References	We did not perform a literature review to define this concept. We needed to depict from where the data to measure the indicators would be sourced to assess if the existential viability of the indicator. This would also inform the scope of the change effort to acquire the measurement data for the indicators. We did not want to include in the scope of change, indicators that could not be measured.

Visual Semantic Modifications

Measurement Tool Symbol	
	*Rationale:* A rectangle with a dark blue outline and a white interior is similar to the dark blue rectangle with a light blue interior used for "Indicator." A measurement tool is tightly linked one or more indicators the similarity of the symbol portrays this tight link.

5.2.4.3 Conceptual Modeling Methods Design Changes

We also refined the modeling methods. We added "Indicator", "Measurement Tool" and "Technology" semantic constructs to the change initiative scope modeling method. We did not use the "Journey Activities" semantic construct as it was not pertinent to the feedback on change scope that the consultants required in this intervention. This seems to suggest that either these

added and removed semantic constructs are optional for depicting the scope of change for an entire offering or that we need two different modeling methods. I decided at this point to stay with one modeling method with optional semantic constructs as I could conceive of a situation, based on my own consulting experience, where Journey Activities and Indicators and Data Sources could all be useful on one change initiative scope diagram. For example, in the EMR scope diagram in the first intervention, there was no attention given to measuring the intended benefits of the EMR in the clinics. Adding indicators and measures to the EMR program scope diagram would support attention and design effort to determine the level of benefits realization. Testing this assumption is left as a task for future research.

We made two changes to the business activity scope diagram type. We added the semantic construct "Guide" and added a design principle that only the pertinent semantic constructs that were changing in form or use, needed to be depicted. A summary of the changes to the conceptual modeling methods is described in Table 8.

Table 8 - Conceptual Modeling Method Enhancements in Intervention Two

ID	Method Principle	Rationale
TA.1	Instances of the following semantic constructs should occur on a diagram to explain the high-level scope of a change initiative: Stakeholder, Change Journey Activity, Capability, Direct Outcome, Indicator, Measurement Tool.	Indicator and Measurement Tool can be useful in the early stages of scoping the change initiative. Including these constructs can help change designers verify the intended outcomes are measurable and identify the work & resources necessary to measure outcomes.

ID	Method Principle	Rationale
TA.2	Change Journey Activity, Indicator and Measurement Tool are optional per the purpose of the diagram	The first and second interventions were each in a different stage in the change design and implementation process and were experiencing different communication challenges. Therefore, the emphasis of the change initiative scope diagram was different in each intervention. Per the PoN principle of Cognitive Fit the content of the diagrams should be limited to that which is directly pertinent to the diagram purpose. This purpose may be different at various stages of the change process.
TB.1	Instances of the following semantic constructs should occur on a diagram to explain the scope of change to a specific business activity: Business Activity (single instance only), Stakeholder, Process, Technology, Behaviour (a.k.a. Responsibility or Key Expectation), Information, Guide.	If there is significant changes to or creation of new "guides" that inform the delivery of the service or execution of the business activity it can be useful to include these in the change scope diagram so that associated work and resources to create and/or modify the guides is included in the subsequent change planning effort.

ID	Method Principle	Rationale
TB.2	Inclusion of the different types of resources on the business activity scope diagram is optional depending on which resources would be undergoing change	Per the PoN principle of Cognitive Fit the types of semantic constructs displayed on a business activity change scope diagram depends on which resources are changing. For, example if there are no changes to the contents or use of any Guides, then Guides do not need to be depicted on the diagram.

We did not resolve the duplicate symbol issue for "outcome" and "behaviour" (key expectation). The two consultants performing the role of co-designers had neither the time nor the interest to resolve this design issue. There were no obvious indications of confusion nor any questions or comments made by any of the project participants regarding the two semantic constructs having the same symbol. This design issue was left to be addressed in the third intervention.

5.3 Intervention 3: Refining Change Scope

5.3.1 Intervention Background

During the third intervention we focused on the Service Change Scope diagram type and conceptual modeling method. This intervention provided the opportunity to use and refine the diagram right from the start of a change initiative when identifying, prioritizing and envisioning the desired service change. We developed and evaluated a new type of diagram to describe the current challenges and adapted and further expanded the service change scope diagram type. We also developed a very simple diagram layout to assist in communication challenges within the

project team, however we did not have the opportunity during the intervention to evaluate this diagram.

The third intervention occurred with a healthcare inpatient stroke rehabilitation unit. The unit leadership wanted to embark on transformative service change. The unit had previously experienced failure in multiple attempts to implement change. They had not made it past the design stage in most cases. Where they had implemented change, the changes were soon abandoned by staff. The medical director and the program director believed that lack of effective staff engagement in scoping and designing the change was a significant factor contributing to the failures. This time, they wanted to include as many of the unit staff as possible to ensure the change design would work for everyone. They hoped more engagement would encourage staff to feel ownership of and commitment to the change. They explained to me, however, that their biggest challenge with staff engagement was the lack of time for staff to participate in change design activities. Nursing staff worked shifts and physicians worked part-time on different schedules. Many of the rehabilitation therapists, such as speech therapists and psychologists worked across multiple units and were not fully resourced. Their capacity to participate in change design was severely limited due to their heavy workloads. In addition, the organization had limited budget and few available resources to backfill them.

The unit directors wanted to design and implement transformative process change to improve patient outcomes, increase service performance and quality, and enhance the working environment for staff. But both directors did not want another failed change. They were willing to participate in additional research activities if the project would improve staff engagement and enable more successful change, even though they both had significant time constraints themselves. I met multiple times with the directors to clarify their change drivers and establish a

common understanding of the general extent of desired change. The challenges they described were numerous. The potential changes envisioned by the medical director were extensive. To develop change design capability in their staff, manage the change implementation risks and not overwhelm staff with too much change at once, I recommended a multi-staged approach. We agreed that this research project would focus on scoping the first stage of the change.

5.3.2 Intervention Setup

The directors wanted to complete the first stage of change within one year so that the staff could experience tangible results that would build their capability and motivation to design and implement further change. We started our discussion on the scope of this first stage with the question of what to change first. Although the directors had identified many challenges during our previous discussions, the program director suggested the staff should also participate in identifying service delivery challenges before identifying the first stage of change. This would serve as a critical step to develop staff ownership of and commitment to the success of the change. It would also enable the directors to identify any potential gaps between their own perspectives of the challenges and the staff's perspectives. Knowing these gaps would enable the directors to adjust their own perspectives as necessary and understand some the staff's motivation for change. With this in mind, we defined the following intervention objectives.

Intervention Objective 1: Engage as many stroke rehab unit staff as possible, with minimal impact to budget and schedules, to define and prioritize current service delivery challenges faced on the stroke rehabilitation ward.

Intervention Objective 2: Engage a representative group of staff to define the scope of the first change initiative and build broad commitment to implement the change.

The directors were very interested in using and assessing diagrams generated from the conceptual modeling grammar, but they did not have the capacity to participate in co-design. Thus, our attention in this intervention was focused on adapting the conceptual modeling methods designed in the previous interventions and refining the grammar. With this focus we defined two design objectives.

Design Objective 1: Use and refine the service change scope conceptual modeling method to facilitate collaborative determination of what to change first.

Design Objective 2: Resolve the outstanding duplicate symbol issue for the goal semantic construct.

We divided the intervention into two sequential stages, with each stage focused on one intervention objective. We mapped out the different stakeholder groups for the first intervention and devised a unique plan of engagement for each stakeholder group. Although the intervention was focused on the stroke rehabilitation ward, the first stage ended with a meeting with all the rehabilitation program managers to review the prioritization of the challenges and determine the focus for the second stage. At this point the program director left for another position in the organization. The new program director had other immediate priorities but appointed the stroke unit manager to assist the medical director to coordinate the second stage of the intervention.

The unit manager then engaged a group of her staff to participate as the change design team for the first change initiative. This team met weekly over several months. The first six weeks were spent on building a team perspective and trust amongst the participants and equipping them with collaborative design skills. Over the subsequent six weeks the team determined what they would change first. We also had small group meetings with each discipline

so that most of the staff in the unit could have an opportunity to provide input into the desired outcomes and scope of the change initiative. The intervention concluded with the change design team drafting a high-level design for the first change initiative and an iterative implementation plan. Figure 25 provides an overview of the research outputs and the outcomes of this intervention. Table 9 at the end of the next section, provides a summary of the activities that occurred during this intervention.

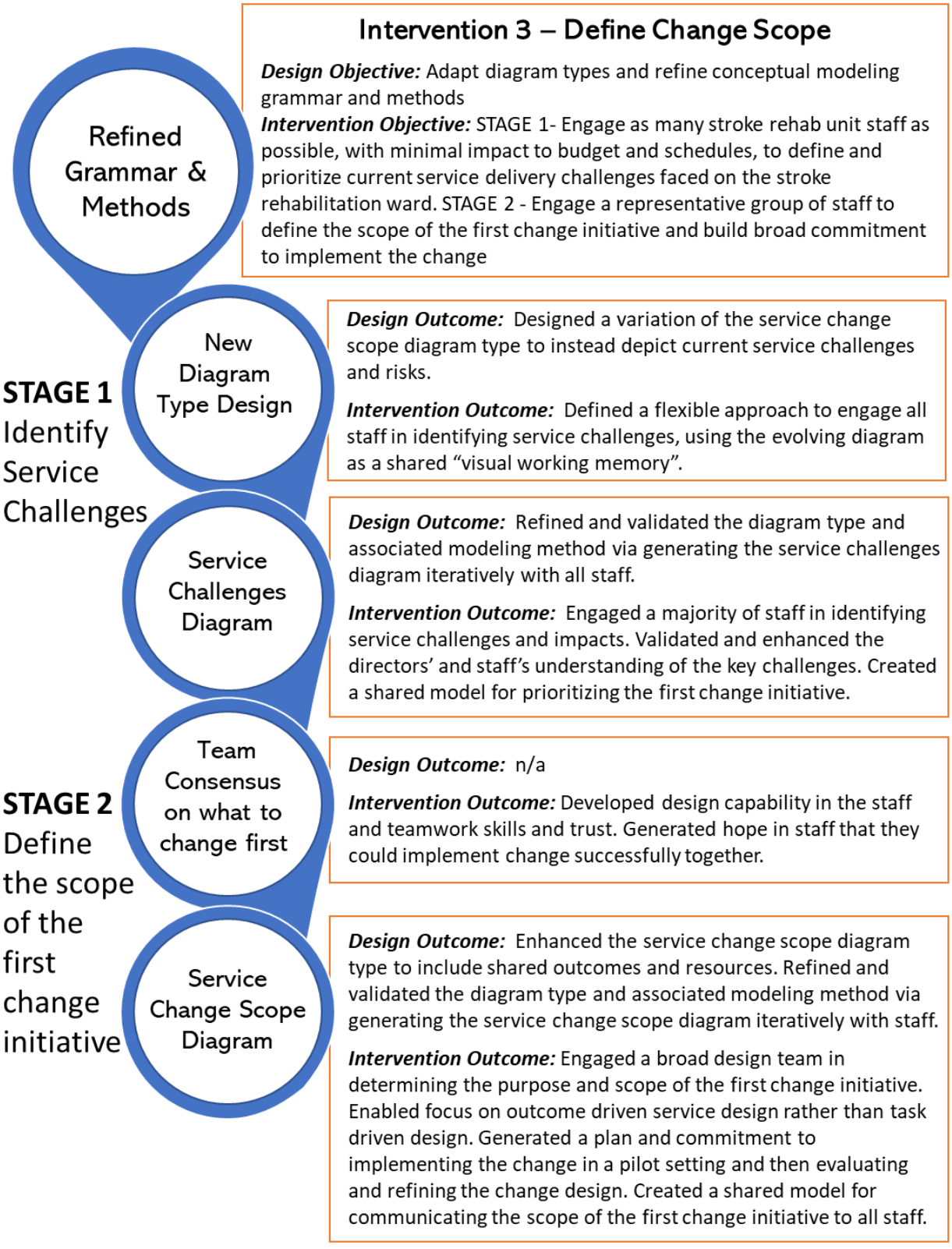


Figure 25 – Research Outputs and Outcomes of the Third Intervention

5.3.3 Stage 1 Story – Identify Service Challenges

5.3.3.1 Designing the Service Challenges Diagram Type

The directors and I reviewed the diagrams generated in the previous intervention. We decided to adapt the service scope diagram by overlaying challenges on the applicable process symbols and replacing the outcome column with negative impacts (risks) to staff and patients. We made this decision primarily based on our first design objective to adapt the conceptual modeling methods previously developed. In addition, the program director wanted a mechanism to help focus conversation on one topic at a time. In previous sessions with staff she had found it difficult to keep the conversation focused. Staff kept changing the topic and repeating their own challenges throughout the sessions. She felt staff often did not listen to other people's challenges.

In all our sessions we found that focusing the conversation on everyone's challenges in one process area at a time enabled more productive discussion and people did not keep returning to their own challenges. Another benefit of adapting the service change scope diagram type was that when we came to design the scope of change in the second stage of the intervention, the diagram layout and many of the constructs were already familiar to staff. This increased the cognitive integration (Moody, 2009) of the two diagrams and thus reduced the cognitive effort and time for staff to understand the second diagram layout.

Another adaptation we made was to add an icon to the stakeholder semantic construct. This was the only semantic construct on the diagram that did not have a symbol. There had been no indications of confusion about the stakeholder construct in the previous interventions. However, the medical director was trained in graphic design and he felt that the diagram would be more visually consistent if all the semantic constructs were symbolized by an icon or a shape. I performed Google and Bing image searches for "people icon" and we selected the round head

and inverted “U” shoulders icon common in both search results (see the Appendix for the search results). We selected green as the colour for the icon, since green is associated with plants and life and people are the living part of an organization.

The fourth adaption we made to the diagram layout was to add the overall performance goal of the stroke rehab service. The medical director wanted to reinforce the purpose of the inpatient stroke rehabilitation service as he felt the staff did not have a unified understanding of the service’s core goal and boundaries. This led to a discussion between the medical director and me on the best symbol to use to represent the semantic construct of performance goal. I suggested we use three concentric circles representing the target board often used in darts and bow and arrow practise. We verified this suggestion by performing a Bing image search and a Google image search for “goal icon.”

The first page of both these searches were predominantly populated with various forms of concentric circles (see the Appendix for the search results). This suggests that it is common to link the concept of a shooting target with the concept of goal. To support the organization’s emphasis on improving patient experience, we decided to use different colours to distinguish patient experience goals from operational goals. Since we were using green in our stakeholder icons, we choose green concentric circles for customer/client experience goals. We chose blue to represent operational goals to minimize impact on people who are colour blind. The most common colour blindness is between green and red, with blue and yellow being the second[1]. Therefore, green and blue should be distinguishable for people with colour blindness.

[1] https://www.nei.nih.gov/learn-about-eye-health/eye-conditions-and-diseases/color-blindness

5.3.3.2 Developing the Service Challenges Diagram and Validating the Design

We built the first draft of the service delivery challenges diagram during a 2-hour session with all the managers of rehabilitation units. We used large, coloured stickies and a poster board. The managers first identified the stakeholder groups and major process areas. We then focused on each process area at a time. Everyone was given 5 minutes to write down their top challenges on stickies. We then went around the table asking each person to read one sticky and then asking anyone else who had written a similar challenge to read their sticky. We collected all the stickies in a pile and a manager from another area in the hospital synthesized the discussion on the challenge to one sticky. I then posted this sticky on the board and we moved on to the next person and the next challenge. We repeated this process until all the stickies were read. Engagement in the discussion increased as the meeting progressed, and the diagram gradually evolved on the poster board as depicted in Figure 26.

Conversation was focused on one challenge at time and no one returned to their own pet challenge repeatedly throughout the meeting. Every single manager contributed to the conversation. Discussion became energetic and people challenged assumptions behind each other's challenges as they tried to arrive at a succinct label for each challenge and its impact on staff and patients. At the end of the meeting the staff took a couple of minutes to look at the diagram and they all confirmed that it represented the top process challenges for the rehab units from their perspectives. This was the first time the program director had documented and achieved consensus on the top service delivery challenges.

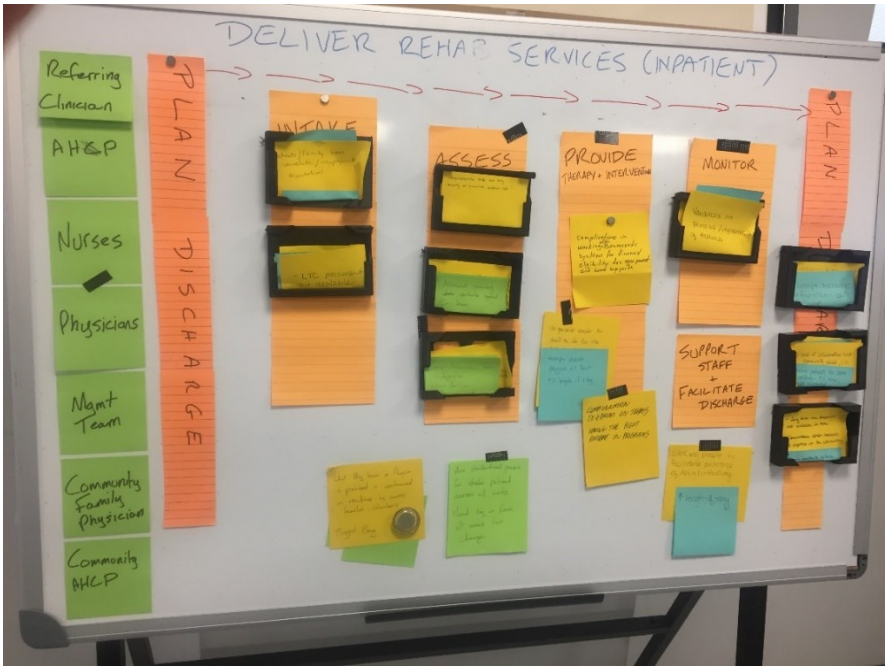


Figure 26 - Services Challenges Poster Board from First Manager's Meeting

To reduce time and effort for staff engagement and still achieve quality collaborative input and staff ownership of the diagram, we decided to iteratively develop the diagram rather than starting from scratch with each group of staff. I reconstructed the poster board diagram in a modeling tool, reviewed it with the medical director and printed it out for the next group of staff. This first version of the services challenges diagram is depicted in Figure 27.

I gave each group a 30 second explanation of the purpose and layout of the diagram and then asked them to look at the diagram and (a) identify the challenges on the diagram that had the most impact on them and (b) identify any additional challenges not shown on the diagram that they experienced in each process area. We took the poster board to every session and posted yellow stickies for each challenge people identified and blue stickies for each staff or patient impact. I updated the diagram regularly in the modeling tool and generated a new printout for the next group(s) to review.

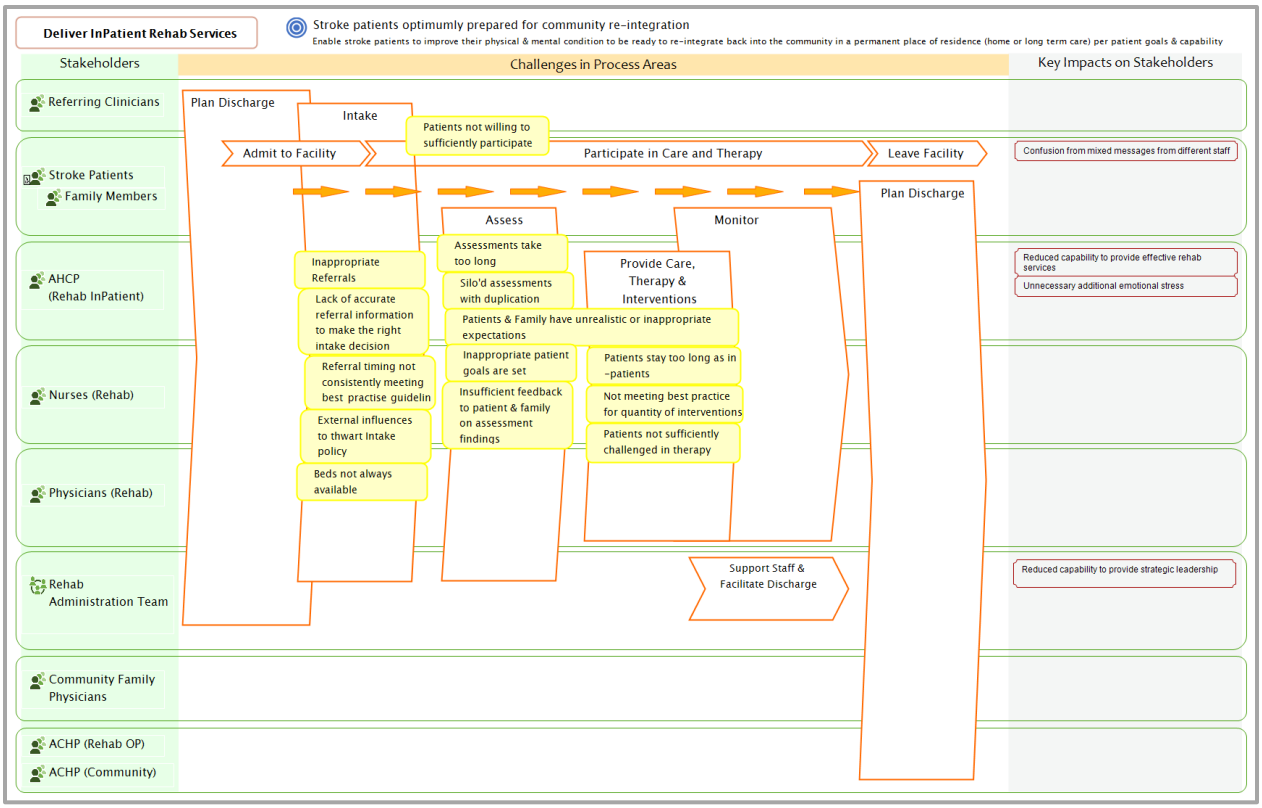


Figure 27 - First printed iteration of Stroke Rehabilitation Services Challenges

We interleaved groups from different disciplines in our schedule so that we could get feedback from the various disciplines on the challenges identified by other disciplines. We started with a 15 minute session with a small group of physicians, then a 90 minute session with the rehabilitation specialists, then a few small groups of nurses who meet for 15 to 20 minutes during their shift, then met with the remaining physicians in pairs or trios and ended by meeting with the remaining nurses in pairs and trios and finally again with the managers to review the input from staff.

Almost every participant in the meetings took time to review the diagram to answer the first question. In most cases they referred to the existing challenge using the label on the diagram. Sometimes someone would express that the challenge as labeled did not fully represent their view of the challenge. Discussion ensued amongst the meeting participants and most of the

time they decided on adding a new challenge. Out of the 28 staff who participated in these meetings, there were only three, all nurses, who paid little attention to the diagram. Two of them appeared to have come to the meeting with a strong intent to air their issues. One of these issues was a long-standing human resource issue. The other issue was a medical equipment issue which the unit manager was unaware of and resolved within the next few days. The third nurse was very new and kept her eyes on the senior nurse in the group the entire time.

Most of the sessions involved thoughtful discussion and questioning each other as the participants tried to articulate impacts and new challenges in a succinct manner to fit on a sticky. Two people, a physician and a nurse, came to their respective meetings determined to say very little or nothing because they felt it would be a waste of time. The nurse looked at the diagram for about 30 seconds and asked if I had any control over making change happen. I replied that everyone's input would be added to the diagram and be presented to the directors. She then launched into a detailed account of the impacts to staff and patients of some of the challenges depicted on the diagram. She ended up staying longer than her 15 minutes, identifying new challenges, and explaining the impacts on nurses and patients. She told us at the end of the meeting that she come to the meeting intending to say nothing as it would likely be a waste of time.

The medical director informed me that the physician mentioned above generally disliked most meetings as he viewed them as unproductive. This physician had previously expressed that he preferred to spend his time getting the work done. The medical director convinced him to come to the meeting by assuring him it would be 15 minutes maximum. The physician arrived in a rush and sat down very stiffly at the table. After the usual one-minute explanation of the meeting purpose and diagram layout, he looked at the diagram for 5 seconds and immediately

identified a challenge he felt was significant. He then launched into an explanation how that challenge impacted staff. Without any prompting from me he continued identifying more challenges on the diagram he felt were significant describing their impact and ideas he had to resolve them. His explanations were very succinct, so I was able to easily capture his ideas on stickies. The medical director also directed the physician's attention to certain challenges on the diagram and asked his opinion. The physician seemed to immerse himself in the discussion. By the end he was sitting back in his chair, his face was relaxed and animated and he looked like was enjoying himself. When he ran out of challenges to talk about, he asked if I had any questions for him. By this time, the meeting had lasted almost 45 minutes. I asked him what he thought about the diagram. He replied that he liked the process flow. He found that putting the challenges on the process flow helped to show where the biggest problems were in the overall process. He suggested that once everyone's input was on the diagram, all the rehabilitation physicians should get together to discuss it and identify what and how to make changes. The medical director mentioned to me later that this was a very unexpected suggestion from a physician who hated meetings.

In contrast, many of the rehab therapists engaged in minimal discussion in their group session. Everyone identified their significant challenges, but after each person read their sticky there was very little discussion. The same two or three people did most of the talking on a few challenges that were common to them and half the therapists joined in a discussion of previous failure to streamline the assessment form. The unit manager, who was present at the session, suggested to me that perhaps the lack of discussion was due to starting with a populated diagram rather than creating it from scratch. However, when I reviewed the brief survey responses which everyone completed, two people wrote they felt uncomfortable discussing challenges in front of

other disciplines and five people wrote they felt awkward with the new manager present. Only one person specifically mentioned the diagram in her response and wrote that she "liked the presentation of the process areas and the challenges as a place to start."

We made a few changes to the symbols and colours during this review process with staff. These changes are demonstrated in the final version of the challenges diagram in Figure 30 - Final InPatient Stroke Rehabilitation Service Change Scope Diagram. We darkened the outline of the symbol for challenge from bright yellow to brown. The bright yellow outline was difficult to distinguish from the light yellow background. Since the focus of the discussions was on prioritizing and identifying challenges, we wanted the challenges to grab the reader's attention. We first tried putting some white space in between the symbols but the two co-designers and I felt the dark outline created more perceptual discrimination of each challenge from the other physically proximate challenges and from the process symbols. The darker outline also enabled us to apply the PoN principle of cognitive fit and optimize the visual expressiveness of the diagram to help focus the conversation on process challenges.

We started with a red rectangle shape with indented corners to represent the negative impact on stakeholders of the challenges. However, the co-designers remarked there were a lot of boxes on the diagram that made it seem complicated. We then tried using an icon with the label adjacent to it. This reduced the amount of lines on the diagram and increased the perceptual discrimination of risk from challenge and process. Since increasing perceptual discrimination decreases cognitive load, this is likely why we perceived the diagram as being "less busy" using an icon. To determine the icon, we performed Google and Bing image searches for "risk", as the co-designers perceived impact as a form of status quo risk. We selected the exclamation mark as it was the most common symbol that appeared in the image search.

There were a few questions about the diagram design from various people with whom we met. Three people asked if the challenges were associated with the stakeholder that the challenge horizontally lined up with on the diagram. One nurse said she found it confusing that the processes and impacts were "lined up with the people" but not the challenges. The program director also asked if the challenges were related to the stakeholders. When one of the managers asked this same question in the final manager meeting, two other managers immediately answered "No" and explained it was because the challenges were applicable to multiple stakeholders. The vertical position of challenge symbols was not something I had explicitly explained to anybody during the meetings. I had mentioned to each group that the process areas vertically extended across related stakeholders, the impacts horizontally aligned with the stakeholders and the challenges horizontally extended across related process areas. Based on the participant comments mentioned above, it seemed to cause visual dissonance for some people that process area symbols and impact symbols were positionally aligned to stakeholder symbols, but challenge symbols were not.

The program director had several other questions about the diagram layout. She told me she was not a visual person and generally did not like conceptual diagrams. In addition to experiencing the same visual dissonance regarding the alignment of challenges, she was trying to figure out the meaning of symbol shapes and positions where there was no meaning intended. For example, she wanted to know why the process shapes "were bent" and why there was more space between some challenge symbols than others. She also did not understand the arrow flowing between the two instances of the discharge planning process. In response to her comments I adjusted the diagram to ensure that all the challenge shapes had no space between them.

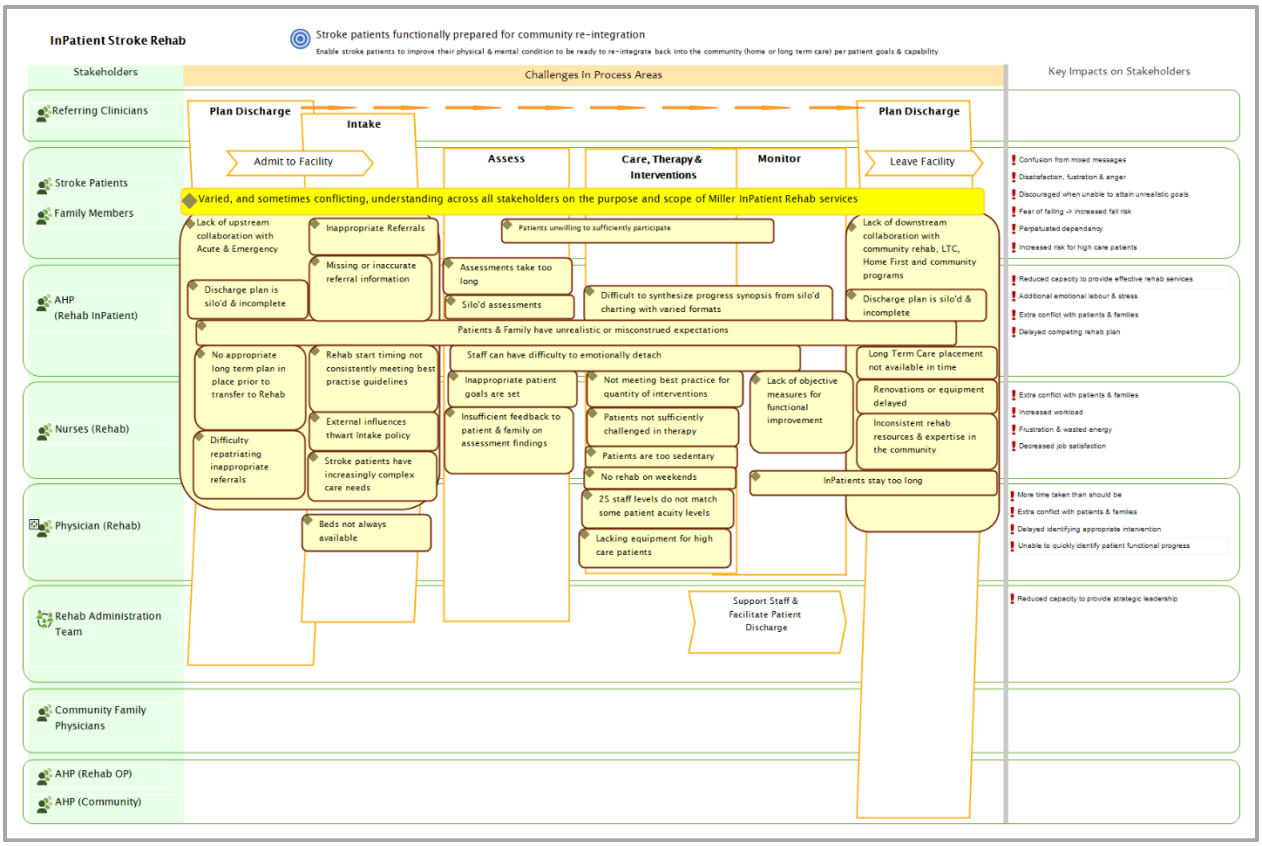


Figure 28 - Final Version of InPatient Stoke Rehabilitation Service Challenges

The medical director led the final review meeting with the managers and used the finale iteration of the diagram (Figure 28) to walk the managers through the challenges. Although she said she had found the diagram difficult to follow at first, she had no problems using the diagram to facilitate the discussion. As during the first manager meeting, the managers remained on topic and discussion was focused on each challenge without repeating previous conversation. The medical director had asked me to place an icon on the all the challenges that she determined were in some way related to the "misconstrued patient expectations" challenge. Most of the challenges ended up with this diamond icon and she used this visual cue to lead an insightful discussion with the managers. During this discussion they came to a joint realization that the expectations for the scope of stroke rehabilitation services was not only inconsistent across patients, but also

varied across staff and to some degree across themselves. This realization set the context for the second stage of the intervention.

5.3.4 Stage 2 Story – Define the Scope of the First Change Initiative

5.3.4.1 Gaining Team Consensus on the Focus of the First Service Change

The medical director and the stroke unit manager assembled a change design team of representatives from each rehabilitation discipline, including various therapists, nurses and physicians. This team's responsibility was to determine the first set of challenges to address and to scope out a solution. The stroke unit manager also recruited two past stroke patients through the organization's volunteer patient advisor program. The medical director persuaded the local medical association to provide an experienced facilitator with whom he had worked before. The program director loaned her administrative assistant to schedule the meetings and take observation notes at the group meetings.

We used the service challenges diagram in the first team meeting to frame the possibilities for change in terms of the challenges that could be overcome. We also used the diagram to gain consensus to limit the focus of the first change to one of the four core processes areas over which the stroke unit had total control. Physically pointing to these four process areas on the diagram was helpful over several meetings to pull people back from discussion that was off topic. As in the previous managers meeting, we referenced the diamond icons on many of the challenges to introduce the possibility that each team member might also have different expectations on the scope and purpose of the stroke inpatient rehabilitation service. A few staff asked if they could share the diagram with other members of their discipline in the stroke rehabilitation unit.

Subsequent meetings then focused on building a sense of team and trust amongst the participants and imparting a belief they could successfully implement change with the

appropriate process and tools. We also equipped them with change design skills and assisted them to deepen their understanding of the impacts of the challenges on other health care disciplines in the team. The team members were initially hesitant to choose which challenge(s) should be addressed first. Thus, we added some time to the research project to take them through imagining what the stroke rehabilitation service could look like if many of the process challenges were overcome. We again used the four core process areas as a framework for creating patient and staff experience maps. We mapped the ideal experience, personal challenges, and knowledge requirements onto each process area. Using the same four process areas, enabled us to easily relate the patient and staff experience journeys to the originally identified challenges.

5.3.4.2 Developing the Service Change Scope Diagram

We then started to construct the service change scope diagram focusing first on the impacted stakeholders (these were the patients and the various healthcare disciplines on the rehabilitation unit) and desired outcomes for each type of stakeholder. Since the outcomes were specific to changing this service, we added the direct outcomes construct to the service change scope diagram type. Each discipline identified their own outcomes by describing the information they needed to know and their ideal experience during small group meetings specific to their own discipline (Figure 29). These small group meetings enabled more staff to be engaged in defining the purpose of the change.

Over the next two design team meetings, each team member presented the ideal experience maps of their discipline, which we used to define stakeholder direct outcomes. Visually depicting each discipline's ideal experience sparked some thoughtful discussion amongst the various disciplines. In some cases, a team member in one discipline did not understand why the ideal experience was important to the other discipline. In one situation there were two ideal

experiences that conflicted. One discipline valued informal verbal communication about the patient status as evidence of a cohesive team, however the nurses were anticipating a central spot for a brief written highlight of the patient's status and found informal verbal communication ineffective for ensuring all nurses on all shifts were adequately informed. Someone on the team noticed this ideal experience conflict after the nurses presented their diagram. This led to respectful questioning of the nurses why this way of communication was so important to them.

Out of the resulting conversation, the other disciplines gained a much better understanding of the different challenges faced by the nurses due to their shift work and frequent temporary staff. One nurse mentioned to me after the meeting that it was the first time the nurses had been able to have this conversation with the therapists without feeling like they were complaining about the therapists. A couple of therapists remarked in the group that they had never considered this situation from the nurses' point of view before and that it now made sense to them why nurses would need a brief status written down in addition to the lengthy patient assessment and progress reports that the therapists documented.

We then used this service change scope diagram to reach and document team consensus on stakeholder specific outcomes. During the process of prioritizing what to change, the team had identified some generic team outcomes such as stronger team cohesiveness and better team communication. After going through presenting the discipline specific outcomes, some members of the team requested some of those specific outcomes, which they had not had as their own discipline specific outcomes, be elevated to team outcomes. The team discussed each request and reached consensus on a few of them to be elevated to team outcomes. The nurses' outcome of "easy access to summary assessment information in one spot" was one outcome that was elevated to a team outcome. Elevating this to a team outcome reflected commitment from the

therapists to change their communication methods from informal conversation to a nurse at the station to a brief written note in a common section of the patient's chart.

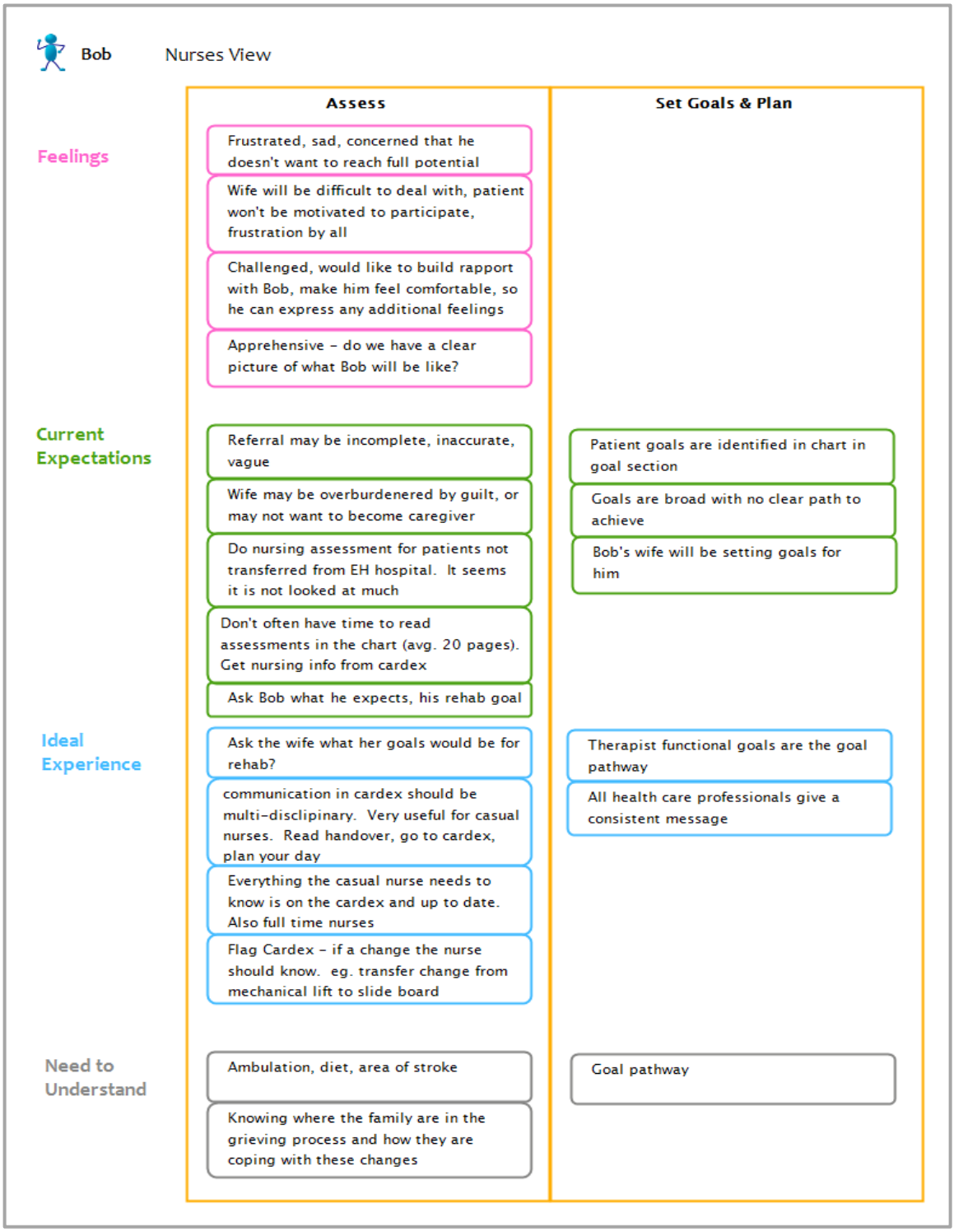


Figure 29 - Sample Experience Map for the Nurses

One outcome that did not transition to a team outcome was “less time to do assessment.” Although most of the disciplines were hoping for this outcome, a couple of disciplines did not do an assessment and therefore this outcome was not relevant to them. In addition, the nurses felt their assessment was already short and concise. Leaving this outcome depicted as a direct outcome for certain stakeholders enabled the team to reach consensus that it was important to design the change to achieve this outcome for those disciplines that currently performed lengthy assessments and at the same time acknowledge that not all disciplines would experience this outcome.

Another notable team outcome that arose out of discussion of the two conflicting specific outcomes was “easy access to summary assessment information in one spot.” Defining this team outcome directly led to the team determining that “Assessment” was the focus process for the first change initiative. With this focus, the team discussed and reached consensus that a significant part of the change should be defining a new common initial assessment tool. I was very hesitant when the team proposed this as the scope of initial change. Revising the assessment process and creating a common assessment tool had been attempted in this unit before and failed miserably. It had not survived the design stage, resulting in discord amongst the team and frustration for the managers. The first program director had mentioned this to me at the beginning of the study as an exemplar change failure for the unit. It had also been mentioned in the first session with the rehabilitation therapists as a bad experience of trying to implement change. There were a couple of other areas of change that had risen to the top during our prioritization process. I suggested they select one of these that had a less fractious history and less emotional baggage attached. However, many of the team members were insistent this new team outcome was a priority for them and thus the assessment process area was what they

wanted to change first. The medical director had told them at the onset of stage two that the decision of what to change first was entirely theirs and so he supported their choice.

We proceeded to develop the service change scope diagram by designing the processes for performing the common and discipline specific assessments. Over a couple of sessions, we generated the diagram depicted below in Figure 30.

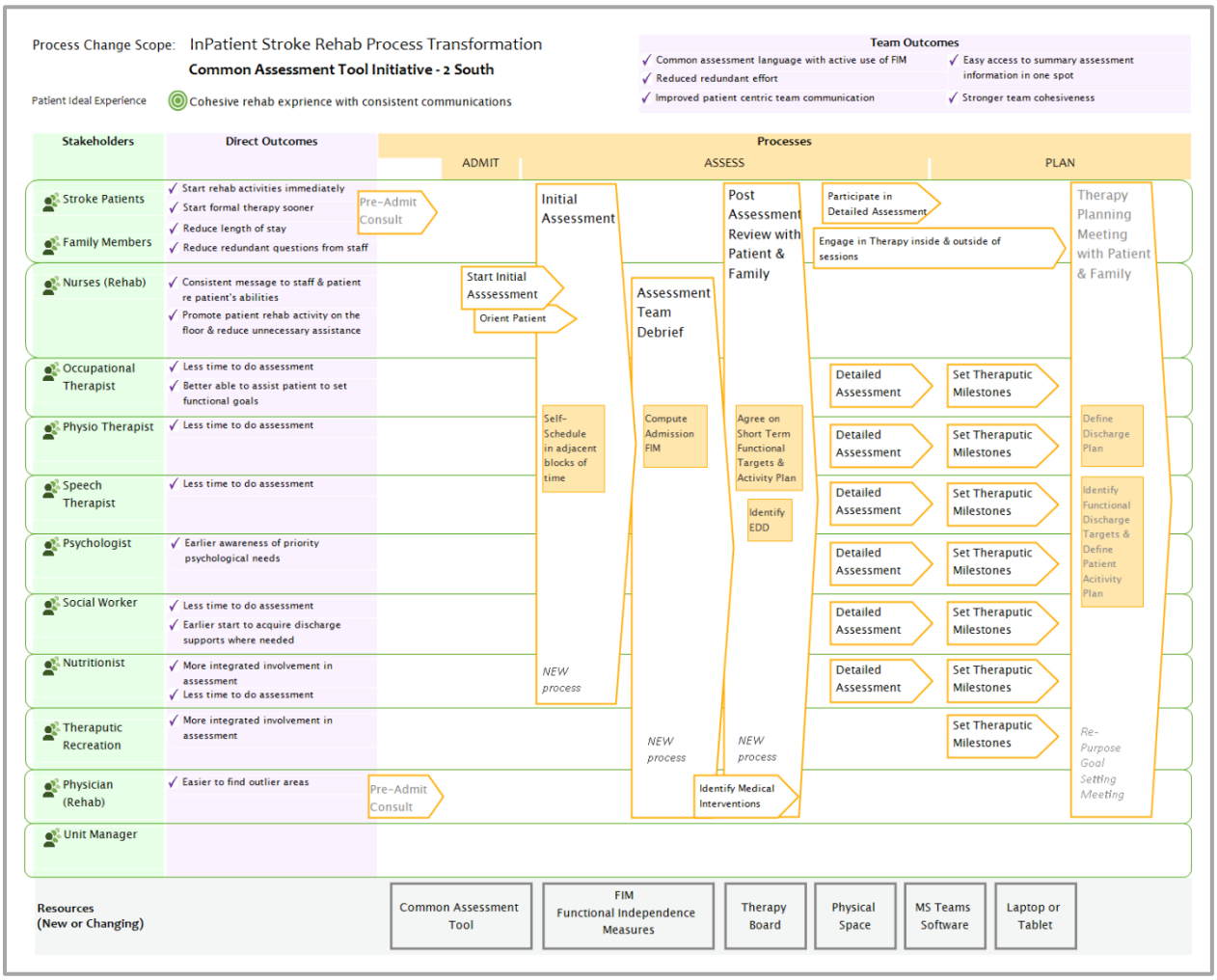


Figure 30 - Final InPatient Stroke Rehabilitation Service Change Scope Diagram

Some of the team members requested the diagram provide some context to the change by depicting processes prior to and following the assessment process that would be changed in future change initiatives. To indicate these previous and subsequent processes were out of scope

of this first change we dimmed the symbols and labeled them in italics as “future.” To depict the resources, including the initial assessment tool, that would be created or modified as part of this change, we added a row at the bottom of the diagram. The team were happy with using the generic construct of “Resources.” Thus, we decided that introducing a set of new symbols to them to represent different types of resources would be an unnecessary visual and cognitive distraction. To minimize the cognitive load of learning one new symbol we chose to use a grey rectangle, to represent any type of resource. Black or grey rectangles are very commonly used in flow charting and healthcare algorithm diagrams to represent various constructs. We chose dark grey instead of black so that the symbols would visually blend in with the pastel colour scheme of the diagram and not stand out. The medical director wanted to ensure attention was focused on the process changes and convey the message that the resource changes supported the new process.

Once we had a solid draft of the service change scope diagram, they were ready to design their common assessment tool. I gave them some instructions on how to design the common assessment tool using the service change scope diagram as a design guideline, specifically the team outcomes and stakeholder direct outcomes and the new process structure. The facilitator helped them construct and execute a plan for designing the new initial assessment tool where they each contributed their pieces individually and in small groups. The team also agreed on a common summary section that the nurses would design. The administrative assistant gathered and merged everyone’s contributions into a single document. The unit manager performed a review to ensure the initial assessment tool was cohesive, and then met with the team to review her suggestions and finalize the tool. We concluded the research project by devising a plan to

pilot and evaluate the new assessment tool and process with the next five patients to arrive on the unit.

Table 9 below summarizes the activities and outputs and/or outcomes that comprised this third intervention.

Table 9 - Activity Summary of Intervention Three

Who	Activity	Outputs / Outcomes
STAGE 1 – Prioritize challenges		
Rehab Medical Director and Rehab Program Director, Researcher	In person meetings to discuss the research opportunity and identify the research scope	Intervention objective and design objectives. Selection of one modeling method from the previous study.
Rehab Directors, 6 Rehab Managers, Researcher	Group meeting to introduce the research, discuss the intervention plan and identify top challenges	First draft of inpatient stroke rehab service delivery challenges diagram
Medical Director, Program Director, Researchers	Individual meeting with each director to debrief on the session with the Managers challenges surfaced so far	Feedback on diagram design and content revisions.
8 Medical Doctors, Medical Director, Researcher	Two individual and two small group meetings to review and build the service delivery challenges diagram	Physicians' contribution to change drivers. Revised inpatient stroke rehab service delivery challenges diagram.

Who	Activity	Outputs / Outcomes
10 Rehab Therapists, Stoke Unit Manager, Researcher	1.5 hour group meeting to review and build the service delivery challenges diagram	Rehab therapists' contribution to change drivers. Revised inpatient stroke rehab service delivery challenges diagram.
11 Nurses, Stroke Unit Manager, Researcher	Four small group 15 – 30 minute meetings to review and build the service delivery challenges diagram	Nurses contribution to change drivers. Revised inpatient stroke rehab service delivery challenges diagram.
Rehab Directors	Meetings to review input provided by project team members and reflect on the previous meetings	Final version of the inpatient stroke rehab service delivery challenges diagram.
Rehab Program Director, 5 Rehab Managers, Researcher	Group meeting to review diagram and discuss change priorities.	Diagram design confirmation. Consensus on the top change priorities input into stage two.
STAGE 2 – Scope first change initiative		
Medical Director, Stroke Unit Manager, Researcher	Meetings to plan the approach and activities for stage 2	Intervention approach and plan. Change Design Team members identified.
Change Design Team, Facilitator, Researcher	12 interdisciplinary design team meetings to prioritize challenges and explore what to change first and the anticipated benefits to themselves and patients	Improved capability to communicate and understand the different discipline perspectives. Improved capability to plan as a team rather than as siloed clinical disciplines Consensus on the outcomes and process area for the first change initiative.

Who	Activity	Outputs / Outcomes
Change Design Team members, additional rehab staff	8 discipline specific small group meetings to review the challenges and provide input to the priority outcomes for the first change initiative	Understanding across rehab staff of the change design process and refinement and confirmation of anticipated change benefits and impacts to each discipline
Medical Director, Program Director, Researcher	Meeting to review change scope diagram and discuss implementation approach	Feedback on diagram design features Consensus on implementation approach
Change Design Team	Individual and small group work to design part of the change	Draft common initial assessment tool.
Change Design Team Researcher	Individual meetings to review change scope diagram	Feedback on diagram design features
Change Design Team, Facilitator, Researcher	Group wrap-up meeting to finalize the change implementation approach	Plan of action with assigned responsibilities for completion of change design and pilot implementation

5.3.5 Summary of Design Findings

5.3.5.1 Diagram Type Utility and Efficacy

In this third intervention, we demonstrated the utility of the diagrams through achieving our two intervention objectives. In the first stage of the intervention we engaged 2 directors, 5 managers, 8 physicians, 11 nurses and 10 rehabilitation therapists to develop a diagram that identified the most significant process challenges faced by the inpatient stroke rehabilitation unit. This diagram also depicted the relationship of processes and impacts to stakeholders and the relationships of challenges to processes. We adapted the iterative diagram generation activities

into existing schedules and shifts with little disruption to workload and service delivery. No additional budget was required for staff to participate. Almost every participant identified their most significant challenges and described the impacts of these challenges on patients, themselves and/or others. Many staff added additional challenges to those presented to them on the diagram. In the first session the managers identified 10 stakeholders, 14 challenges and 4 patient or staff impacts. In the subsequent large and small group sessions, staff identified an additional 15 challenges and elaborated 11 more patient or staff impacts.

The service delivery challenges diagram was the centre piece of every participant engagement in the first stage. Various participants expressed a positive experience regarding the efficacy of the diagram in describing the problem space. The physician who hated meetings reflected that the diagram "crystalizes my thinking of issues I have thought about but not talked about." One of the nurses mentioned "it was helpful to see some of the challenges related to one process area and that some challenges cut right across [process areas]. It is very easy to see this on the diagram."

Several people did experience some cognitive dissonance because the vertical positioning of the challenges had no meaning whereas the vertical positioning of other constructs did have meaning. As one physician commented "You have the stakeholders down the left and the processes extended to show their involvement, but the challenges are all in a cluster. They are not shown by stakeholder like the processes." Others did not perceive any incongruence and commented that the layout of the challenges made sense because the challenges were not specific to any stakeholder group. This difference in perceiving visual incongruence may be an indication that different people perceive visual patterns differently, where some are more influenced by the

consistency of the pattern and others are more influenced by their existing knowledge and reflections on the content.

In the second stage of the intervention a representative team of staff reached consensus on the purpose and scope of an initial change initiative. The service change scope diagram was generated collaboratively and iteratively with the team as they explored and determined the change focus and scope. The concluding version of the diagram contained 12 stakeholders, 18 unique outcomes, 11 unique processes, and 6 resources. This diagram also depicted the relationship of direct outcomes and processes to stakeholders.

In contrast to the first meeting where the team expressed lack of hope anything would change, in the final meeting members of the team expressed they now felt hopeful that the change might happen and could be beneficial for the patients and for them. During the first six weeks, it took deliberate facilitation to induce discussion between most team members of different disciplines. However, during the second six weeks, informal discussions occurred between team members of different disciplines immediately after some of the sessions. During these discussions they talked about the change and how best to implement it. Some of the team members also mentioned they had met a few times between sessions to share their thoughts of how to implement the change.

Generating the service change scope diagram provided the team with a frame of reference for choosing what to change first and for scoping what that change would look like. The diagram was used by various people in the team to share different perspectives, highlight contradicting expectations and facilitate discussion to reach a common understanding and consensus about the change. Broad commitment across the team to implement the change was demonstrated by their active engagement in working together to define a new common initial assessment tool. In the

final meeting the team created a plan to implement the tool in a short pilot. They also agreed on how they would measure the pilot's success, through identifying measures linked back to the outcomes depicted on the diagram.

5.3.5.2 Conceptual Modeling Grammar Design Changes

We enhanced the ontology to include the concept of the risks to stakeholders arising from the challenges perceived prior to the initiation of change. These can also be viewed as the risks to stakeholders of not implementing change and remaining status quo. Implementing change that mitigates status quo risks could contribute to stakeholder value. "Change Risk" and "Status Quo Risk" are variants of the much broader concept of Risk. Since the use of "status quo risk" in this intervention was limited to the negative impact on stakeholders, we narrowly defined this concept as "Stakeholder Status Quo Risk." However, the concept of organizational change risk requires a more extensive literature review and deeper analysis to increase the concept's clarity and validity. Another change we made to the ontology was to add a new relationship "pertains to" between perception and resource. This new relationship was reflected in the service challenges diagram by associating challenges, a subtype of perception, with process areas, a subtype of resources.

During this intervention we added symbols for the stakeholder, risk and resource semantic constructs. We did not resolve the duplicate symbol issue for goal and behaviour. The participants were happy with the check mark. Since we did not use the behaviour construct in the diagrams that we developed, there was no opportunity for confusion. This meant there was no motivation for the participants to explore another symbol for "goal." The changes made to the ontology and the grammar during this third intervention are defined below.

Ontology Modifications

Existing Concept	**PERCEPTION**
Existing Definition	The way in which something related to the change is regarded, understood, or interpreted.
New Relationship	Pertains to RESOURCE (0-n)

New Concept Subtype	**STAKEHOLDER STATUS QUO RISK** Sub-type of Change Risk
New Definition	Anything that negatively impacts stakeholders involved in the area under consideration for change prior to any change occurring.
New Relationships	Impacts Stakeholder (1-n) Influences VALUE (0-n) Influenced y PERCEPTION (1-n)
References	This concept and the definition arose out of the need to describe the various impacts on stakeholders of the identified service delivery challenges. An extensive literature review has not yet been performed.

Visual Semantics Modifications

Stakeholder Symbol	
	***Rationale:*** The head and shoulders icon is commonly used to represent a person, as evidenced by the first page of Google and Bing image searches on "people." Three icons together reinforce the idea that the stakeholder concept is group of people. Green is commonly associated with life and people are the "living organisms" in an organization. Three shades of green represent that the group of people share common attributes but are not necessarily the same in all respects.

Risk Symbol	
	***Rationale:*** The exclamation mark within a triangle or other shape is commonly used to represent risk, as evidenced by the first page of Google and Bing image searches on "risk." Due to the small size of the icon on the diagram, the exclamation mark was not very evident within a triangle shape. Therefore, we removed the triangle shape and only used the exclamation mark for the icon. Red and black were the most common colours in the icon image searches performed. We selected red to increase the perceptual discriminability of the icon attached to black text.

Performance Goal Symbol	
	***Rationale:*** Three concentric circles are commonly used to represent a target or a goal, as evidenced by the first page of Google and Bing image searches on "goal." Green is used for customer/client experience goals since green is the colour we use for stakeholders. Blue is used for operational goals since there are no known colour-blind issues in distinguishing green and blue.

Resource Symbol	
	***Rationale:*** Black or grey rectangles are very commonly used in flow charting and healthcare algorithm diagrams to represent various constructs. Therefore, using a grey rectangle would be familiar to the diagram users. We chose dark grey instead of black so that the symbol would visually blend in with the pastel colour scheme of the diagram.

5.3.5.3 Conceptual Modeling Methods Design Changes

We achieved our first design objective of using and refining the service change scope conceptual modeling method in both stages of the intervention. We were able to adapt the same modeling method to depict both the scope of the problem and the potential scope for the first stage of service delivery change. However, some constructs were only portrayed on one or the other type of diagram. Stakeholder impacts, such as challenges and risk, were documented

depicted only on the service delivery challenges diagram. Outcomes and resources occurred only on the service change scope diagram.

To facilitate a parsimonious definition of the service delivery challenges and service change scope modeling methods we identified the common principles and elevated these to generic service scope modeling method. We then specialized the service scope method into two sub methods, one for each diagram type. This hierarchical method design enables future additional specializations of the service scope modeling method for generating similar diagrams that may have other different purposes. For example, a service change roadmap of iterative change implementations. The definitions for each of the modeling methods are described below.

Service Scope Modeling Method Modifications

Modeling Method: Service Scope (New)

The following principles described in Table 10 were elevated from the Service Change Scope modeling method to the new Service Scope modeling method.

Table 10 - Conceptual Modeling Method Enhancements in Intervention Three

Method Principle	Rationale
Instances of the following semantic constructs should be included on any sub-type of the service scope diagram: Stakeholder, Process	These semantic constructs were common across both service challenges and service change scope diagram types.
The symbols for processes may vertically extend across the stakeholders who are involved in the process	Extends Principle A.10

Method Principle	Rationale
Processes should generally be placed in horizontal order of when the process starts.	Extends Principle A.3
Detailed process flow is not to be depicted on a service scope diagram	Extends the principle of PoN Cognitive Fit. The purpose of this diagram is to depict scope not detailed design. Therefore, the process flow should depict generally what happens during service delivery not the detail of how it happens.

Modeling Method: Service Challenges (New)

The following principles described in Table 11 define the new modeling method for the Service Challenges diagram type.

Table 11 - New Modeling Method for Service Challenges

Method Principle	Rationale
Inherits the principles of the Service Scope method	The service challenges diagram type has a similar layout and shares many visual semantic constructs with the service scope diagram type
Instances of the following semantic constructs should additionally be included on the service challenges diagram: Service	Challenges and the impacts of these challenges on stakeholders are the focal point of the service challenges diagram

Goals (Performance Goal) Challenges, Stakeholder Impact (Status Quo Risk)	
The symbols for challenges should vertically overlay the symbol(s) for the process(es) to which the challenge applies	Enable stakeholders to quickly identify which challenges are applicable to which processes and which challenges are common across more than one challenge. Extends the common principles A.2 and A.4
The symbols for stakeholder impact should horizontally align with the stakeholder experiencing the impact	Extends the common principle A.5

Modeling Method: Service Change Scope (Modified)

The principles that were elevated to the Service Scope method were removed from the definition of the Service Change Scope method and replaced with a single principle of inheritance. The following principles described in Table 12 were then added to this modeling method.

Table 12 - Enhancements to Service Change Scope Modeling Method

Method Principle	**Rationale**
Inherits the principles of the Service Scope method	The service change scope diagram type specifies elements specific to communicating the changes to the service scope.
Instances of the semantic construct Direct Outcome may be depicted	Where the direct outcome is specific to a service rather than an overall change program, depicting the direct outcome on the

Method Principle	Rationale
	related service change scope diagram highlights this specific service relationship.
The symbols for Direct Outcome should horizontally align with the symbol for the stakeholder benefiting from the outcome	Extends the common principle A.5
Instances of the semantic construct Resources may be depicted rather than instances of specific resource sub-type semantic constructs.	Using the same generic resource symbol for any type of resource may reduce cognitive load in situations where depicting specific resource type does not add value to the change communication.

5.4 Summary of the Interventions

In each intervention we refined and expanded the three design artifacts that make up the design theory. These design artifacts are the domain ontology, the notation of the conceptual modeling grammar and the principles for the conceptual modeling methods. In each intervention we identified design objectives for refining the design theory and defined intervention objectives for evaluating the utility and efficacy of the design theory. We developed and evaluated variations of four diagram layouts with corresponding conceptual modeling methods and implemented. The development of the design theory was iterative within and across the three interventions. In each design, implement and evaluate iteration within each intervention we applied and built on the learnings from the previous iteration.

Through using these artifacts to determine and communicate the scope of service change, we accomplished the intervention objectives of the second and third interventions and uncovered hidden misunderstanding of the scope of the change in the first intervention. This demonstrated the utility and efficacy of the design theory. The final chapter summarizes our learnings and highlights the results achieved by this research.

6 DISCUSSION AND CONCLUSION

Many organizations struggle to engage busy stakeholders in scoping change initiatives because the communication mechanisms are cognitively intense and time consuming. The purpose of this research was to begin to design a visual language that could be used to communicate the scope of organizational change in a concise manner. Using such a visual language is anticipated to contribute to improved stakeholder engagement in understanding and/or defining the scope of organizational change. Thus, stakeholders need to perceive communication created by using this visual language, as easy and quick to understand. To ensure we addressed this need, we founded the design of the visual language on conceptual modeling and visual notation theories and then collaboratively advanced the design with busy stakeholders during organizational change initiatives. Developing and using the visual language to communicate change scope in-situ enabled us to validate and improve its utility and efficacy.

6.1 Design Theory and Intervention Outcomes

Action Design Research produces design theory in the context of solving a real-world problem (Sein et al., 2011). Design theory is developed for the purpose of achieving specified intervention outcomes that reflect some aspect of solving the problem. Design theory can then be evaluated in terms of how well the intervention outcomes were achieved by implementing design theory. Our design theory consisted of a model integrating the domain ontology, the conceptual modeling grammar, and the conceptual modeling methods to effect quick and easy comprehension of change scope for impacted stakeholders. Table 13 demonstrates how our design theory fits with Gregor and Jones (2007) template for specifying a design theory.

Table 13 - Design Theory Components

Component	Visual Language for communicating scope of change
Scope and purpose	Design a visual language that can be used to communicate the scope of organizational change in a manner that is quick and easy to comprehend.
Constructs	The set of constructs to be depicted by the visual language is included in the definition of the domain ontology. Examples are stakeholders, desired change outcomes, business activities, processes, resources, and actions.
Principles of form and function	The conceptual modeling grammar defines corresponding visual semantic constructs for each ontological construct and principles of visual representation. The conceptual modeling methods define principles for the content and layout of different types of diagrams representing various aspects of the scope of organizational change
Artifact mutability	The diagram types were adapted to three different organizations and change communication purposes.
Testable propositions	The fundamental design goal for this theoretically based and collaboratively defined visual language was to improve the speed and ease for stakeholder comprehension of change scope.
Justificatory knowledge	The domain ontology was framed using sensemaking theory, and concept definitions were developed through literature review. The modeling grammar and methods were based on PoN and its underlying theories, along with other visual cognition theories,
Principles of implementation (optional)	Although, not directly articulated as principles, the implementation approach deployed in each intervention is described.
Expository instantiation (optional)	Samples of the diagrams generated in each intervention are provided.

Because we applied the ADR method to intervene in organizational change initiatives, we were limited in our ability to directly measure our design goal of improving the speed and ease of comprehension. Therefore, we indirectly evaluated this goal by defining related intervention objectives and evaluating the outcomes of the interventions based on these objectives. To do this we first identified a baseline communication challenge for each intervention. We then defined intervention objectives that described the result of overcoming the challenge. To evaluate how the design theory contributed to achieving these objectives, we identified specific outcomes for each objective. Each outcome was related to improving ease and speed of comprehension of the scope of service change.

Each of the three interventions occurred in a different healthcare organization experiencing a unique stakeholder engagement or communication challenge at a different stage of the change initiative. These multiple interventions enabled us to design a comprehensive visual language and enhance the validity of the design evaluations. Table 14 summarizes how the achievement of intervention outcomes contributed to the assessment of achieving of our intervention objectives and thus our design goal.

Table 14 - Intervention Outcomes & Evaluation

Intervention Objective	Intervention Outcomes	Outcome Evaluation
Intervention ONE Improve the effectiveness of the lab result distribution service communication material for (a) hospital staff so that they	Identified and quickly rectified inconsistencies in the team members' understanding of the electronic lab results distribution processes.	Intervention ended pre-maturely. However, the previous inconsistent team understanding, and miscommunication of the change scope likely contributed to the confusion of the hospital staff and physicians.

Intervention Objective	Intervention Outcomes	Outcome Evaluation
understand the data they need to enter and (b) physicians so that they select the appropriate routing configuration that meets their needs.	Team developed consistent and accurate understanding of the new processes, the impacts of the change and the critical success factors for implementation.	Team self-identification and resolution of several comprehension gaps while going through the diagrams was considered an indirect indicator of improved comprehension of the change scope.
Intervention TWO Overcome the current stakeholder engagement blockage, gain feedback and agreement on the proposed scope of change from the project participants and gain approval from the steering committee	1) Clarified the consultant's understanding of the scope and impact of the change.	Consultants self-identified and resolved different understandings of the change scope while developing the diagrams
	2) Re-engaged all team members in the change process. Enhanced team understanding and documentation of the scope and impacts of the change.	All team members, except one who was traveling, met with the consultants to review the diagrams. Team members provided additional input to the change scope while reviewing the diagrams. Content analysis of the review meeting observations and interview recordings using four indirect comprehension indicators demonstrated improved understanding of the scope of change.
	3) Achieved team member consensus and steering committee approval of the scope of the change	Steering committee members reached agreement on the scope of change while reviewing the diagrams and subsequently signed off the business case.

Intervention Objective	Intervention Outcomes	Outcome Evaluation
Intervention THREE STAGE 1- Engage as many stroke rehab unit staff as possible, with minimal impact to budget and schedules, to define and prioritize current service delivery challenges faced on the stroke rehabilitation ward.	1) Engaged many staff in identifying service challenges and impacts.	Engaged 2 directors, 5 managers, 8 physicians, 11 nurses and 10 rehabilitation therapists via 10 meetings during regular shifts.
	2) Validated and enhanced the directors' and staff's understanding of the key challenges. Created a shared model for prioritizing the first change initiative.	Participants identified 10 stakeholders, 29 challenges, and 15 patient/staff impacts. Management had not been previously aware of the extent of some of these challenges.
STAGE 2 - Engage a representative group of staff to define the scope of the first change initiative and build broad commitment to implement the change	1) Developed design capability in the staff and teamwork skills and trust. Generated hope in staff that they could implement change successfully together.	The design team moved from low participation and an expressed sense that change in their unit was not likely to be successful to active participation in the collaborative design activities and a sense of hope they could improve the way they worked as a team.
	2) Engaged a broad design team in determining the purpose and scope of the first change initiative. Enabled focus on outcome driven service design rather than task driven design. Created a shared model for communicating the	Directly engaged 2 physicians, 2 nurses, 2 physiotherapists, 1 occupational therapist, 1 recreation therapist, 2 speech therapists, 2 psychologists, 2 clinical nutritionists, 1 ward manager, 2 previous patients in the design team. Held a session with each of 8 disciplines including an additional 17 people. Identified 2 patient experience outcomes & 10 direct stakeholder

Intervention Objective	Intervention Outcomes	Outcome Evaluation
	scope of the first change initiative to all staff.	outcomes. Defined 5 shared team outcomes for the stroke rehab ward. Identified the collaborative and individual sub-processes for the Assess and Plan processes. Identified 6 new resources to be used throughout the processes.
	3) Drafted a common initial assessment tool	Previous attempts to do this had failed because there was not a common understanding of the needs of all the disciplines. This time staff understood the different needs of the different disciplines by going through the process of generating the process scope diagram.
	4) Generated a plan and commitment to implementing the change in a pilot setting and evaluating and refining the change design.	The diagram was used as a reminder of the goal of the plan and the boundaries of the scope of the plan. The stakeholder and team outcomes and the scope of the process change documented as articulated by the participants appeared to promote commitment to the change. Participants referred to these when defining the success measures for the pilot and were able to agree on these success measures.

6.2 Artifacts

The design theory developed during this research consisted of three artifacts: the domain ontology, the conceptual modeling grammar, and the conceptual modeling methods. The design of each artifact was theoretically based to ensure quality and further elaborated and evaluated in collaboration with the participants in the three interventions to test validity and ensure utility and efficacy.

6.2.1 Ontology

We defined an initial draft of a domain ontology for organizational change focused on process and technology change. We used organizational sense making theory as the kernel design theory to guide the scope and contents of the domain ontology. To create the ontology concept definitions, we performed a literature review across multiple subject areas. These subject areas included change management, strategy, strategy as practise, outcome management, requirements engineering, business process management, conceptual modeling, and other formal ontology definitions. We evaluated, refined, and added to the ontology through using it to generate change scoping diagrams in each of the interventions.

For most of the concepts, it appeared the definitions were adequate for the purpose of the diagrams. However, we did not end up using all the concepts. Of the 19 top level concepts we defined in the initial domain ontology we explicitly mapped 12 top level concepts on the diagrams we generated during the interventions. We did not explicitly map all the sub-types of "perspective", such as need and concern. Although we discussed needs and concerns during the third intervention, there was not sufficient time and resources to create and evaluate the design of a stakeholder perceptions diagram. We also did not explicitly map the concept of "value." All three interventions focused on stakeholder outcomes and the intervention leaders were not

interested to develop value propositions. Therefore, we added a relationship between "stakeholder" and "goal" to indicate outcomes desired by stakeholders. We did not perform any detailed solutions design and so did not use the concept of "design requirement." We did not use "channel" and "infrastructure" as these two sub-types of "resource" were not relevant to the healthcare interventions we engaged in. Since we only performed three interventions, all of which were in healthcare, we cannot conclude that these concepts are not generally relevant to scoping change. We can only conclude that not all concepts are relevant to all change initiatives.

We also did not explicitly identify the concept of "role" in the diagrams, but rather labeled roles as stakeholders. For example, a "nurse" could be considered a "role" in the delivery of stroke rehabilitation services and "unit manager" is an organizational role. "Patient" can also be considered a role in a healthcare service. "Nurse", "unit manager" and "patient" were all identified as types of stakeholders in the diagrams we generated. This tight relationship of "stakeholder fulfils role" enabled the use of "stakeholder" instances to identify process roles. Using the same stakeholder instances on both the "program change scope" and "process change scope" diagrams promoted cognitive integration between these two diagrams. However, all three interventions were centred on process change. This same level of cognitive integration across diagrams might not be possible for organizational change that is not focused on process change. Cognitive integration might also might not be as high where the change is more complex involving multiple processes and the same stakeholder type plays different roles in different processes.

We did not perform any risk modeling, however, in the third intervention we added the concept of "status quo risk" which we defined as a sub-type of "change risk." This concept was added so that we could identify the impacts to each stakeholder of the perceived challenges of

the current state of service delivery. Identifying the impacts informed the process of prioritizing the challenges and scoping subsequent change initiatives.

We encountered one concept that was perceived or termed differently by the participants in the three interventions. The term "behaviour" was disliked by some participants. The purpose of this concept is to represent behaviour changes necessary to achieve the desired outcomes. The designers in the first intervention decided they would like to represent behaviour changes by defining responsibilities for each stakeholder. The designers in the second intervention felt that "responsibility" was too narrow to encompass all behaviour change. They decided to use the term "key expectation" meaning expectations of stakeholder responsibilities and actions. The participants in the third intervention wanted to make a significant behavioural change from operating mostly independently as disciplines to operating as a team across disciplines. They were not ready to directly discuss and document discipline specific behaviour changes. Instead they indirectly identified common behaviour change by defining team outcomes on the process scope diagram. They also discussed a specific outcome the nurses desired and raised this to a team outcome. The nurses wanted highlights of a patient's issues and progress to be documented and accessible in one spot rather than orally communicated. By reaching consensus to raise this to a team outcome the therapists agreed and committed to changing their own communication behaviour. In these interventions we discovered multiple ways to discuss and indicate behaviour change. Given this variety in only three interventions, it may not be possible to nail down a common term and a one-to-one method of mapping behaviour change to a single construct on the diagram.

The concept of "change journey activity" was added in the first intervention to describe temporal activities specific to implementing the change. This concept was not used in the

subsequent two interventions. However, the first intervention had already performed their first of many site implementations and experienced issues. The next two interventions had not yet reached the implementation phase and were not focusing on the implementation journey during the research period.

In the second intervention we added the concept of "measurement tool" to identify the source of the measurement data. This concept was added to ensure the outcome indicators could be measured and identify new measurement tools that would need to be included in the scope of the change. The third intervention did not use this concept. It was acknowledged that since they did not use electronic medical record on the ward, all indicators would need to be manually measured. Defining the manual methods of collecting the necessary data was beyond of the scope of the intervention.

The third intervention started at an earlier stage of the change process than the previous interventions. The first goal was to identify and prioritize the current challenges to inform the scope of the first change initiative. To build on their strategic direction of developing process improvement capability we took a process centric approach and mapped challenges to process areas. To support this, we added the relationship between "perception", of which "challenge" was a sub-type, and "resource."

During the three interventions, we were able to use and validate most of domain ontology concepts we had defined through a literature review. We also extended the domain ontology by added three new concepts and three pairs of relationships amongst existing concepts. The concepts we consistently used across all three interventions were "stakeholder", "outcome", "business activity", "process" and "resource" or various other sub-types of resource such as technology, information, and guide. We did not use the concept specific to developing a

customer value proposition and a few resource sub-types that were not relevant to the three interventions, such as channel and infrastructure. However, because our sample size is too small, we cannot make any assessment of whether the concepts that we did not use are relevant or not to scoping organizational change.

6.2.2 Conceptual Modeling Grammar

We designed an initial conceptual modeling grammar consisting of one-to-one mapping of 18 concepts in the domain ontology to visual constructs. We then applied PoN theory to design symbols for 14 of these visual constructs. During the three interventions we defined symbols for three visual constructs for which we had not already defined a symbol. We also defined three new visual constructs, along with corresponding symbols for the three new concepts we added to the domain ontology.

During the interventions we did not encounter any obvious confusion with the meaning of any of the symbols we defined. We assume this is because we applied PoN theory to the symbol design and made extensive use of the principle of dual coding. In addition, for the three constructs that used icons instead of shapes, we co-designed the icons with the intervention participants and thus selected icons that were intuitive to healthcare workers. However, through the co-design we ended up with two duplicate symbol issues. We defined a gray rectangle for "change journey activity" and "resource." Each symbol was co-designed with a different set of participants in a separate intervention and each intervention only used the one visual construct, not both. Thus, there was no sense of need on the part of the participants to resolve the duplicate symbol issue. Low participant motivation in addition to lack of time and constrained participant availability prevented us from resolving this duplicate symbol issue.

The second duplicate symbol issue was the use of the checkmark icon for the stakeholder "outcome" construct and the stakeholder responsibility and action change ("behaviour") construct. In this situation, the same set of participants in the same intervention used both visual constructs but in different diagrams. Again, there was lack of motivation on the part of the participants to resolve this duplicate symbol issue. We did not observe any obvious sign of participants confusing the concepts and the design team were happy with the check mark for both constructs.

There may be an ontological reason behind acceptance of the same symbol for both constructs. The definition we used for outcome was "a specific, measurable result or effect of a changed action or situation" (ACMP, 2014). The definition we used for behaviour was "The way in which a person conducts herself/himself in fulfilling a role in the organization." However, when scoping change, the participants described behaviour change that was desired, not the current behaviour. It is conceivable that if participants believed the desired behaviour would not occur unless the change was implemented, then they could perceive desired behaviour as the behaviour that is hoped to result from implementing the change. This could explain why using the check mark icon for both constructs did not cause confusion.

Another way to analyze the lack of participant issue with the duplicate checkmark icon is the broad use of the checkmark itself. Within healthcare, checklists are frequently used in service quality assurance processes. These checklists are mostly focused on personal action, for example performing a task, or verifying a task has been performed. As such, the service quality checklists are essentially promoting consistent, appropriate behaviour in delivering healthcare. More generally, checkmarks are used to denote something has been completed (for example, a task list), something has been achieved (for example, a list of goals), or something is correct (for

example, an answer on a test). This itself is a common duplicate, or rather triplicate, symbol issue. However, we are quite familiar with it and most people are generally able to determine if the checkmark means correct, completed, or achieved. Therefore, it may be that general familiarity with multiple uses or meanings of the checkmark icon, combined with dual coding of the construct type, eliminates confusion as to the concept represented by the checkmark. Thus, general familiarity with the multiple uses of an icon, in combination with the PoN principles of dual coding may override the PoN principle of one-to-one symbol to construct mapping.

6.2.3 Conceptual Modeling Methods

We designed three types of diagrams and created a hierarchical set of conceptual modeling methods that provide guidance to the generation of these diagrams. We applied sense making theory to define the common layout and content design principles for all three diagram types. To enable people to make sense of the change, to understand how the change impacts them and how they fit in the purpose of the change, all the diagram layouts were stakeholder centric. To decrease the perceived complexity of the diagrams and increase the ease of stakeholder engagement with the diagrams we minimized the use of lines and used spatial positioning to infer relationships between instances of concepts on the diagrams. During the first intervention we applied the BPMN swim lane construct to the diagram layout by designing a lane for each stakeholder and positioning instances of other constructs related to the stakeholder in the stakeholder's lane. This stakeholder motif was repeated across the other two diagrams types to increase cognitive integration between the diagrams and decrease the cognitive load of learning a new layout.

We defined a purpose for each diagram type and constrained the types of constructs depicted on each diagram type to only those pertinent to the diagram purpose. This enabled the

generated diagrams to be depicted on a single page. We chose the constraint of a single page because it responded to input from physicians and observations from others that a physician was likely to feel too busy to read anything longer than a page. We found a single page was easy to hand to nurses sitting in the small coffee break room on the ward. They could conveniently hold it in one hand and look at it while we facilitated discussion on the diagram contents. In the first intervention we engaged the entire team by presenting one diagram at a time on the screen. We were able to have a focused and complete discussion on the topic of the diagram and then move on to the next diagram and topic.

The purpose of the first diagram type was to depict the scope of a change to a program or offering, including the scope of impact to stakeholders. It included the stakeholders involved in the program, the direct outcomes anticipated for each type of stakeholder and the new or changing business activities within the program. Business activities were vertically elongated across stakeholder lanes to indicate which stakeholders would be involved in the business activity and thus would be impacted by the change. The direct outcomes for each stakeholder were shown at the end of each stakeholder lane. Where the same direct outcome applied to multiple stakeholders it was repeated in each stakeholder lane.

We further defined two variants of the program change scope. One variant was designed to be used at the very beginning of the process of defining program change. It focused on scope of program change and the scope of measurement tools that would be needed to evaluate the achievement of the direct outcomes. This was considered an important determination to make very early in the change scoping process because many of the resources to perform these measurements were not in place. Identifying new measurement tools and processes early enabled these to be included in the change scope. The other variant of the program change scope was

used closer to the implementation of the change. It focused on identifying the scope of program change and the scope of effort to prepare for and implement the change. To achieve this focus, it depicted the activities in the journey to prepare for and implement the change. Similar to business activities, the change journey activity symbols were elongated across the lanes of the stakeholders who would need to participate in the activity. This enabled stakeholders to get a sense of where they fit in the change implementation process. Outcome measures and tools were not depicted.

The purpose of the second diagram type was to depict the scope of change to the processes and other resources of a specific business activity or service. This business activity could be part of an overall program change as depicted on the program change scope diagram as in the first and second interventions. Alternatively, this business activity may be the sole focus of a change initiative as in the third intervention. We generated two of these diagrams in the first intervention for two different business activities and one in the second intervention. In the third intervention we generated one service scope change diagram to depict the scope of the first change initiative identified for this service. We defined the various resource types as optional constructs for the service scope diagram type to enable the diagram to be tailored to each change situation and depict only those types of resources that would be undergoing change or newly acquired or created. The process symbols were elongated across the stakeholder lanes to identify which stakeholders were involved in the process. The diagrams generated in the first two iterations also included the stakeholder action or responsibility changes at the end of each stakeholder lane. In the few situations where more than one stakeholder needed to make the same action change, the action instance was repeated for each stakeholder.

We defined a variant of the business activity change scope diagram in the third intervention. Because this intervention was focused on changing one service, we had not created a program scope diagram. Thus, the stakeholder direct outcomes needed to be depicted at the service level. To achieve this, we added direct outcomes to the service change scope diagram. We also removed the behaviour change construct. Instead, behaviour change was indirectly represented through outcomes and process change. The most significant behaviour change that the participants desired was to work more cohesively as a multi-disciplinary team rather than as siloed disciplines. This was reflected in three different ways on the diagram. First, the team jointly defined a set of team outcomes which depicted the shared outcomes of implementing team behaviour. We placed these shared team outcomes at the top right of the diagram. Second, we elongated the new "Initial Assessment" process symbol across multiple stakeholders (which reflected the various clinical disciplines in the team) to show that this was a collaborative process. We repeated the "Detailed Assessment" process symbol in each relevant stakeholder lane to show this process was individually completed by each discipline. Third, the team discussed and agreed to the specific outcomes for each discipline. Specifically, agreement with the two outcomes defined by the nurses would require behaviour change by some of the other disciplines. These new and modified actions were discussed in the process of reaching agreement but not explicitly shown on this diagram.

We defined a third diagram type to identify the current process challenges faced in delivery of a service and support the prioritization of service change by process. The layout for this diagram followed the layout for the service change scope diagram type, depicting stakeholders in lanes, along with the processes the stakeholders are involved in. We added the top-level performance goal for this service at the top of the diagram to serve as a reference point for the

challenges. This helped to focus the participants on challenges that hindered the achievement of the service goal. Instead of depicting resources, the diagram depicted challenges pertinent to one or more processes. The challenge symbols were placed inside the process symbols to which they applied. In the few instances where a challenge was common across multiple processes, the challenge symbol was horizontally elongated across the processes. It is not possible in a two-dimensional diagram to depict the relationships of challenges to processes and also to stakeholders.

We chose to show the relationship of challenges to processes for two reasons. First, the organization wanted to change one process at a time. To prioritize the process to change first we needed to assess the challenges associated with that process. Second, many challenges were common across stakeholders and only a few were common across processes. Thus, depicting the challenge to process relationship was considered more useful to the purpose of the diagram.

However, just by being placed within a process symbol, a challenge symbol appeared within a stakeholder lane. This caused confusion for some participants who interpreted the challenge as being particular to that stakeholder. Confusion was alleviated with a brief explanation that challenges were not specific to stakeholders. The diagram accomplished its purpose of engaging stakeholders to identify the full set of significant challenges faced by any of them in performing the processes required to deliver the service. It supported the determination of which process to change by developing confidence across the stakeholders that all major challenges had been identified and thus would be considered. It did not contain enough information to be used as the sole source of input for assessing the impacts of the challenges, but it did provide guidance as to which process to change first based on the assessment of the challenges.

6.1 Research Contributions

6.2.4 Academic

In addition to the design theory for a visual language to communicate the scope of change, this study made further contributions to the academic body of knowledge in the areas of conceptual modeling, ADR methodology and change management.

The Physics of Notations (Moody, 2009) has been used as a framework for evaluating numerous visual notations used by conceptual modeling grammars. This thesis represents the first application of using PoN to design the visual notation of a conceptual modeling grammar from scratch. We used the PoN to design each symbol and to provide guidance to the common layout of the different types of diagrams. There is always creative choice in how to implement the PoN and some principles can contradict another. However, the definitions of the principles provided useful information to evaluate our choices to best achieve the purpose of each diagram. This enabled us to make creative design decisions in a rational manner. This research validated that the PoN can be useful in the design of a visual notation.

The Physics of Diagrams (Pissierssens et al., 2019) is very recent at the time of writing this thesis and there has not yet been much opportunity for this design theory to be tested. We were able to validate some of its design principles during the evaluation of the design of the diagram layouts as described above. This could encourage future researchers to apply and test the guidelines outlined by Pissierssens et al.

Mullarkey and Hevner (2019) elaborated on the Action Design Research methodology first proposed by Sein et. al. (2011). We validated several of these elaborations by applying them to our iterative design process during the three interventions. We implemented the “build,

implement, evaluate" (BIE) stage iteratively as a full ADR cycle in each intervention and as two ADR cycles in the second intervention. We did find, as Sein and Rossi (2019) proposed, that it was valuable to return to the problem formulation stage at the beginning of each iteration and articulate the stakeholder engagement problem specifically for each intervention. Even though each intervention problem fit the same general class of problem, the manifestation of the problem of engaging busy stakeholders in designing change, was different in each situation. Returning to tailor the problem definition for each iteration enabled us to perform contextually specific evaluation of the effectiveness of the design in resolving each intervention's stakeholder engagement challenge. We also focused attention on the concept design activity as outlined by Mullarkey and Hevner (2019). Prior to commencing each BIE cycle, we tailored the concept design to the intervention by discussing the scope of contents and the layout of new diagram types and identifying enhancements to existing diagram types that would best serve the objectives of the intervention. Finally, Mullarkey and Hevner (2019) proposed, and Sein and Rossi (2019) agreed, that the final stage of formalized design and learnings could also occur part way through the ADR cycle as well as at the end. We implemented this proposed expansion to ADR by formalizing the design and learnings from the second intervention in a conference paper prior to initiating the third intervention. Our application and validation of these proposed ADR expansions can serve as an example which future ADR researchers can draw on and further develop.

We responded to the call for more healthcare research on technological and process change to be performed in-situ (Greenhalgh & Stones, 2010) by performing our research in the context of current change initiatives in healthcare. We described some of the research challenges faced in designing an artifact in-situ as well as the benefits to the artifact design and the organization. We

also described how we used an abductive approach to investigate and integrate seeming design compromises. Our research may encourage future researchers to consider the ADR method. It may also serve as an example to ADR researchers who encounter similar in-situ design challenges and inspire them to take the time to investigate and reflect further on design compromises to determine if there is opportunity to enhance their design principles.

This thesis complements research from various fields that touch on an aspect of organizational change. It utilizes organizational sensemaking theory to bring together concepts used for describing the scope of organizational change within various disciplines, into a unified domain ontology. The focus of this initial domain ontology is service change, including change to technology, process, roles, responsibilities, and behaviour. As the pace of change has increased, so research on organizational change has increased, not only in the organizational development field but also in other fields as diverse as strategy and requirements engineering. While different fields will build different sets of concepts suitable to their purposes, mapping these concepts to a common domain ontology could promote common understanding and information sharing across these research disciplines and potentially encourage further integrated and multi-disciplined research.

We contributed to academic conversations on the interdependencies of change communication, stakeholder engagement and stakeholder resistance. Each intervention demonstrated the positive impact on stakeholder engagement of using change communication tools that were comprehensive and yet easy to understand and quick to read. The second intervention also demonstrated that apparent stakeholder resistance to engaging in review and feedback may be due to the complexity of, and lack of time to comprehend, the change communication material rather than personal resistance to the change. In situations like these,

providing enabling mechanisms that reduce the cognitive load and effort for stakeholders to engage can be effective in engaging busy stakeholders.

Finally, we contributed to the discussion on change leadership. We demonstrated how using a visual tool to engage impacted stakeholders in scoping the change, illuminated gaps in the leaders' understanding of who and what needed to change. This thesis adds examples to the research on the processes and tools for realizing the benefits of greater stakeholder participation in the strategic change decision making processes.

6.2.5 Practitioner

The domain ontology produced by this research provides a common terminology for change management practitioners and will be submitted to ACMP for consideration in a future revision to the terminology section of the ACMP Standard. Organizations can take this ontology and tailor the names of the terms to fit within their organizational vocabulary. This can help ensure that everyone is using the same terminology and the same meaning when change scope is being discussed and determined.

There are currently no common visual tools for depicting the high-level scope of organizational change. Most change practitioners use spreadsheets and ad hoc diagrams when scoping change. The visual language defined in this research can be used and adapted by consultants or organization leaders to engage their teams in scoping process and/or technological change. Like the business model canvas helps entrepreneurs consider all the key aspects of a new business model, the program change scope and service change scope diagram types can help changes leaders engage their impacted stakeholders to identify and consider the critical components of their change initiatives. The conceptual modeling methods provide guidance on

how to generate these types of diagrams. The diagrams generated during the interventions can be used as examples for practitioners when generating their own diagrams.

The explanation of the kernel theory underlying the visual language design principles can enable practitioners to better understand why each design principle is important and when one principle may need to over-rule another. This theoretical understanding can help them more objectively make their own design decisions as they tailor the diagram types to their own organizational situations and needs.

The intervention stories described in this thesis provide an example to practitioners of the benefits that can be achieved by using a visual language to scope organizational change. Many organizations struggle with insufficient availability of their staff to engage in scoping change. The examples of how busy clinical staff were engaged in periods as short as fifteen minutes in the midst of their shifts can serve as encouragement to practitioners that effective engagement of staff is possible with minimal requirements on staff time and attention.

6.3 Limitations

We started the research with a theory-based design of the visual language, including an initial domain ontology and a visual grammar. The concepts proposed in the domain ontology represent a starting point for defining the scope of organizational change. We focused on process and technological change and did not include other areas of organizational change such as restructuring organizational responsibilities, renovating business models and financial structures, or revising employee compensation models. We added additional concepts as needed during the interventions. But, due to intervention schedule and resource constraints we did not perform a theoretical validation of the concept definitions. This limits the reliability and generalizability of our domain ontology.

Only one diagram was generated and used for each variant of the program change scope diagram type. This limits the reliability of our evaluation of this diagram type. Although these diagrams were understood by participants, we did not have opportunity to explore and evaluate variations in design layout and content. For example, the horizontal order of the groupings of construct types may not be the most effective for quick comprehension. One participant, who joined the project team at the end of the first intervention, suggested that it might be quicker or easier to associate direct outcomes with stakeholders if the direct outcomes were immediately adjacent to the stakeholders rather than at the end of the stakeholder lane on the far right of the page.

The icons were co-designed with healthcare participants and some of the icons may not be as intuitive to people outside of healthcare. For example, the use of the checkmark icon for stakeholder outcomes and behaviour changes may not be intuitive to people outside of healthcare. Also, people outside of healthcare may be confused in using the same symbol for both semantic constructs.

Evaluation in in-situ research relies heavily on content analysis and reflection of qualitative data. This meant that measuring the achievement of the design goals was indirect. We evaluated general effectiveness of the generated diagrams by how well we achieved the intervention objectives for stakeholder engagement. However, evaluation of artifact effectiveness in the context of an intervention presents the opportunity for a multitude of factors that may confound the results of using the artifact. For example, the novelty of a researcher being present and curiosity about the artifacts being used could motivate some participants to be more engaged and attentive than they normally would.

We indirectly measured comprehension speed effectiveness by the amount and relevancy of change design input contributed by participants within various time limits. To mitigate potential comprehension confounding factors within each intervention, we sought to control the engagement environment for the participants as much as possible. For example, each nursing group was interviewed during their break in their small coffee room on the ward, shown the same diagram and given the same brief explanation. Each group consistently identified similar top challenges. This provided some level of assurance that most of the nurses comprehended the diagram within the short time frame we met with them. However, we were not able to determine speed and accuracy of comprehension for specific diagram design features.

To assess the effectiveness of specific diagram features we relied on participants to be forthcoming about aspects of the design they found awkward or confusing. There were issues raised by some participants, but we could not determine the percentage of participants that experienced the same issue as others might have experienced it but not mentioned it. In addition, there may have been other issues experienced by some people of which we were not informed. Although we were able to evaluate the utility of the design principles by assessing whether the diagrams generated by these principles accomplished the intervention objectives, we were not able to assess the level of effectiveness of individual design features in detail.

Participant bias, as previously described in the data collection section, is another limitation that impacts the evaluation of artifact design. We sought to mitigate this as much as possible by encouraging participants to critically reflect on their personal experience with the diagrams. Two participants informed us of their self-professed preference for textual or oral communication and were forth coming with their reflections and opinion on their experience using the diagrams. Several participants identified a design feature they found confusing. We attempted to identify

any participant bias by comparing participant expressed responses with observation notes of how they interacted with the artifacts and to identify seeming contradictions or gaps. We did not identify any obvious contradictions. The design issues raised by participants and the lack of obvious contradictions between behaviour and self-report may indicate that we at least partially mitigated participant bias.

However, the analysis for contradiction between observed behaviour and spoken feedback was superficial. Observations notes are not a reliable source for assessing nuanced behaviour, particularly in group sessions. It is just not physically possible for one or two observers to notice and record everything that everyone in the group is doing. In addition, although several participants raised issues and the few co-designers contributed ideas while creating the initial designs, only two participants directly suggested design improvements after using the diagrams. One participant joined the team at the end of the first intervention and therefore had no personal investment in the diagram design. The second participant was noticeably forthcoming in criticisms and suggestions for doing things differently on various topics unrelated to artifact design. This suggests that a combination of participation bias and lack of sufficient time and motivation to think through the effectiveness of each design feature limited the validity of the evaluation of design.

Having only one researcher record observations and field notes is a significant limitation that carries a high risk of researcher bias in assessing effectiveness of the artifacts. This risk was partially mitigated in the third intervention where an administrative assistant from the organization also recorded observations and summaries of each large group session. Researcher bias was also partially mitigated by including the results of participant surveys and interviews in

the evaluations. However, researcher bias may still influence the interpretation of the survey and interview data and thus negatively impact the validity of the results.

This research included over seventy people with various clinical and administrative job roles, along with two patients and including at least two people who professed they were not visually oriented. Although there was a variety of participants with different roles and expertise, the total sample size is still small. In addition, all three organizations were involved in the delivery of healthcare. Both these factors, sample size and sample variety, limit the generalizability of the findings.

6.4 Future Research

The domain ontology could be expanded, validated, and revised to fill gaps acknowledged in this thesis and potentially discover gaps that have not yet been identified. The concepts of goals, outcomes and behaviour need to be further investigated and clarified. Each intervention organization had a different emphasis and consequent approach for defining goals and outcomes. Further research should be undertaken to determine if "outcomes", "performance goals", and "design requirements" should be defined as separate concepts rather than sub-types of "goal."

Participants in each of the interventions exhibited discomfort with the behaviour concept. The participants in the third intervention circumvented this discomfort by creating team outcomes that reflected changes in behaviour. Further exploration is needed in modeling the concepts involved in culture change, including the core values and beliefs that underpin behaviour (Schein and Schein 2016). There may be merit in further exploration of the concept of outcome-oriented behaviour in a similar vein to the research on the concept of goal-oriented requirements.

The concepts defined in the domain ontology that were not used in any of the diagrams generated in this research require further investigation to validate their definitions and relevancy to the domain ontology. The domain ontology could be further validated and enhanced through a combination of additional literature review, controlled lab experiments for effective comprehension, practitioner interviews and surveys, and organization interventions in other industries.

Further work could be performed on the design of the diagram types and the conceptual modeling methods. We initially defined measures, measurement tools and change journey activities as optional constructs within the modeling method for generating a program change scope diagram. However, to help practitioners maintain a focused communication purpose for each type of diagram, it may be helpful to identify each of the two variants as a distinct diagram type with a distinct purpose. In addition, there may be other constructs that are important to depict in the early scoping of program change in other types of organizations. Hence other variants of the program change scope diagram type may be useful.

Further testing of the diagram layouts, such as horizontal order of construct groupings, and other design features, such as vertical rather than horizontal lanes, should be performed to validate the effectiveness of, and potentially refine the design principles for, the diagram layouts. Controlled comprehension experiments could be performed on various alternatives for the layout of visual constructs to validate and refine the design principles. This would validate or improve the effectiveness of the design principles in aiding user comprehension. The diagrams layouts could be tested in cultures that read right-to-left, such as Arabic cultures, and top-to-bottom, such as oriental cultures to explore whether different layout orientations are needed for people used to these alternate reading orientations.

In addition, eye tracking could be also performed during the comprehension experiments to evaluate the most efficient alternative for a design feature. This would be especially useful for improving the design of the diagram layouts when comprehension results are similar for multiple design feature variants. Eye tracking technology can measure the speed taken to identify the instance(s) of a visual construct salient to the comprehension question down to milliseconds. This level of detailed measurement is difficult with just comprehension questions. Eye tracking technology together with verbal protocol analysis can identify the path taken to find the construct instances salient to comprehension. This can provide insight in any opportunities for modifying the organization of constructs on the diagram to reduce the length of the path (Palash et al., 2019).

All three of the interventions were performed within healthcare. Further research in using this visual language in other industries would validate and improve the language for more generalized use. Researchers could work with domain experts to generate diagrams for change initiatives that have already been scoped using text and ad hoc diagrams. This would identify any gaps or issues in the domain ontology. It would also identify gaps or required variations in the scope of constructs defined for diagram types. The design of the symbols could be validated through controlled comprehension studies with people who work in other industries. This would identify if the symbols are consistently intuitive across industries or if there is a need for new design principles enabling industry variation of symbols.

We suspect that diagrams generated from the modeling language are faster and less cognitively demanding to understand than textual representations. We base this suspicion on previous research in visual and verbal cognition and the short amount of time participants took to read the diagrams during the interventions. Hypotheses could be defined, and controlled

experiments conducted to investigate this further. Participants could be randomly assigned to groups performing comprehension and/or problem-solving tasks using either a diagram or a textual description. The speed and level of understanding could be measured and compared between the groups. These experiments could further control for level of distraction as well as self-professed preference for diagrammatic or textual communication.

Although we co-designed the language with participants, the generation of the diagram content was facilitated by the researcher in every instance. Further research is needed to understand the skills and training needed for a change leader or change facilitator to generate the diagrams using the conceptual modeling methods.

The use of the diagrams in each intervention generated new knowledge for management and employees. Knowledge gaps were exposed and filled in the first intervention. Leadership in the second and third interventions gained new knowledge about current challenges and potential change scope. Employees in the third intervention gained new knowledge about each other and how they wanted to interact. Further research could investigate how the use of such visual change scoping tools affect the quality of various types of knowledge generated, including knowledge needed to motivate and enable behaviour change.

Each intervention occurred at a different stage of the change process. There are numerous frameworks and models for determining and executing change that are used by practitioners. Further research could explore where and how this visual language fits within these models and how use of the language affects the practices of organizational change and strategy execution.

6.5 Conclusion

In summary, this research employed an abductive, multi-disciplinary, and iterative action design research approach to design an initial visual conceptual modeling language for scoping service change in an organization. Building on existing knowledge, the domain ontology describes concepts and their relationships essential to articulating the scope of organizational change. We integrated information systems engineering modeling techniques and kernel theories from information systems, human cognition and learning, organizational development, and change management to build the theoretical foundation for the visual constructs of the modeling grammar and modeling methods. We employed the ADR methodology in organization interventions to expand and test the conceptual modeling language in collaboration with organizational members during organizational change. We employed various qualitative evaluation techniques including observation, semi-structured and reflective interview, and survey to assess the effectiveness of the design of the language. Each of the three interventions in healthcare organizations, achieved the objective of engaging busy stakeholders in understanding and defining the scope of their desired change with minimal impact on their daily workload.

The diagrams created using the conceptual modeling language were generally positively received by the participants. Using these diagrams enabled the participants to focus discussion on the topic at hand and improve their comprehension of the scope of change they were engaged in. One participant, who strongly affirmed he/she was not a visual person and preferred verbal mediums of communication, was able to use a diagram generated with the visual language to facilitate prioritization of change drivers with the management team with minimal effort. Clinicians were able to take as little as 15 minutes during their shift to review the diagrams, provide their insights and opinions, identify gaps, and highlight their specific desired outcomes

of the change. Teams used the diagrams to reach consensus on the scope of their change initiative. They felt confident that their concerns had been taken into consideration and the likelihood of hidden significant gaps was low.

This research demonstrated that is possible to effectively communicate the scope of change in a manner that is quick and easy to understand using a specially designed visual language. The outcomes of the interventions showed that applying theory, such as PoN, to reduce the cognitive load in change communications encouraged busy stakeholders to engage with the communication. The organizations that used this language as a communication tool were able to overcome challenges engaging their busy stakeholders. Participants, who were previously reluctant to engage, were willing to discuss the diagrams generated from the visual language. Comprehension gaps were identified, and stakeholders were able to provide more effective and comprehensive input towards determining the scope of the change. This in turn contributed to participants having greater confidence in the change design and consequently, stronger commitment to moving forward with the change. The design theory underlying this visual language is an encouraging starting point for further work in reducing the cognitive load of change communications and encouraging more successful stakeholder engagement in designing organizational change.

7 REFERENCES

Aagesen, G., & Krogstie, J. (2010). Analysis and design of business processes using BPMN. In *Handbook on Business Process Management 1* (pp. 213-235). Springer, Berlin, Heidelberg.

ACMP (2014), S*tandard for change management*, Retrieved from www.acmpglobal.org/page/the_standard (accessed January 2016)

Al-Haddad, S., & Kotnour, T. (2015). Integrating the organizational change literature: a model for successful change. *Journal of organizational change management*, *28*(2), 234-262. https://doi.org/10.1108/jocm-11-2013-0215

Ashkenas, R. (2013). Change management needs to change. *Harvard Business Review*.

Balogun, J. (2003). From Blaming the Middle to Harnessing its Potential: Creating Change Intermediaries. *British journal of management*, *14*(1), 69-83. https://doi.org/10.1111/1467-8551.00266

Balogun, J., Bartunek, J. M., & Do, B. (2015). Senior managers' sensemaking and responses to strategic change. *Organization Science*, *26*(4), 960-979.

Balogun, J., & Johnson, G. (2005). From intended strategies to unintended outcomes: The impact of change recipient sensemaking. *Organization studies*, *26*(11), 1573-1601.

Bar, M., & Neta, M. (2016). Humans Prefer Curved Visual Objects. *Psychological science*, *17*(8), 645-648. https://doi.org/10.1111/j.1467-9280.2006.01759.x

Barki, H., Pare, G., & Sicotte, C. (2008). Linking IT Implementation and Acceptance via the Construct of Psychological Ownership of Information Technology. *Journal of information technology*, *23*(4), 269-280. https://doi.org/10.1057/jit.2008.12

Bartunek, J. M., Rousseau, D. M., Rudolph, J. W., & DePalma, J. A. (2006). On the receiving end: Sensemaking, emotion, and assessments of an organizational change initiated by others. *The Journal of applied behavioral science*, *42*(2), 182-206.

Bartunek, J. M., & Woodman, R. W. (2015). Beyond Lewin: Toward a Temporal Approximation of Organization Development and Change. *Annual review of organizational psychology and organizational behavior*, *2*(1), 157-182. https://doi.org/10.1146/annurev-orgpsych-032414-111353

Bauer, M. I., & Johnson-Laird, P. N. (1993). How Diagrams Can Improve Reasoning. *Psychological science*, *4*(6), 372-378. https://doi.org/10.1111/j.1467-9280.1993.tb00584.x

Bauer, M. I., & Johnson-Laird, P. N. (2016). How Diagrams Can Improve Reasoning. *Psychological science*, *4*(6), 372-378. https://doi.org/10.1111/j.1467-9280.1993.tb00584.x

Bell, E., & Bryman, A. (2015). *Business research methods* (4th Edition ed.). Oxford University Press.

Bell, G. G., & Rochford, L. (2016). Rediscovering SWOT's integrative nature: A new understanding of an old framework. *The international journal of management education*, *14*(3), 310-326. https://doi.org/10.1016/j.ijme.2016.06.003

Belova, O. (2006). The event of seeing: A phenomenological perspective on visual sense-making. *Culture and Organization*, *12*(2), 93-107.

Bernard, H., Wutich, A., & Ryan, G. (2017). Introduction to text: qualitative data analysis. *Analyzing Qualitative Data*.

Bertin, J. (1983). *Semiology of graphics : diagrams, networks, maps*. Madison, Wis. : University of Wisconsin Press.

Borghesani, V., Pedregosa, F., Buiatti, M., Amadon, A., Eger, E., & Piazza, M. (2016). Word meaning in the ventral visual path: a perceptual to conceptual gradient of semantic coding. *NeuroImage (Orlando, Fla.)*, *143*, 128-140. https://doi.org/10.1016/j.neuroimage.2016.08.068

Boswell, W. R., & Boudreau, J. W. (2001). How leading companies create, measure and achieve strategic results through "line of sight". *Management Decision*, *39*(10), 851-860. https://doi.org/10.1108/EUM0000000006525

Bradbury-Huang, H. (2010). What is good action research?: Why the resurgent interest? *Action research (London, England)*, *8*(1), 93-109. https://doi.org/10.1177/1476750310362435

Brocke, J. v., Rosemann, M., & SpringerLink. (2010). *Handbook on Business Process Management 1 Introduction, Methods, and Information Systems*. Berlin, Heidelberg : Springer Berlin Heidelberg : Imprint: Springer.

Burke, W. W. (2002). *Organization change : theory and practice*. Thousand Oaks, Calif. : Sage Publications.

Burke, W. W. (2017). *Organization change: Theory and practice*. Sage publications.

Burlton, R. (2012). Business process manifesto. *BPTrends,* available at: https://bptrends. com/resources/bp-mmanifesto (accessed 25 March 2013).

Burnes, B., & Cooke, B. (2013). Kurt Lewin's Field Theory: A Review and Re-evaluation. *International journal of management reviews : IJMR*, *15*(4), 408-425. https://doi.org/10.1111/j.1468-2370.2012.00348.x

Campbell, J. P., McHenry, J. J., & Wise, L. L. (1990). MODELING JOB PERFORMANCE IN A POPULATION OF JOBS. *Personnel psychology*, *43*(2), 313-575. https://doi.org/10.1111/j.1744-6570.1990.tb01561.x

Caulfield, J. L., & Senger, A. (2017). Perception is reality: change leadership and work engagement. *Leadership & Organization Development Journal*, *38*(7), 927-945. https://doi.org/10.1108/LODJ-07-2016-0166

Chabris, C. F., & Kosslyn, S. M. (2005). Representational correspondence as a basic principle of diagram design. In *Knowledge and information visualization* (pp. 36-57). Springer.

Coch, L., & French, J. R. P. (1947). Overcoming Resistance to Change. *Human relations (New York)*, *1*(1), 512.

Crabtree, A., Rouncefield, M., & Tolmie, P. (2012). *Doing Design Ethnography* (2012 ed.). London: Springer London, Limited. https://doi.org/10.1007/978-1-4471-2726-0

da Silva, D. L., Souza, R. R., & Almeida, M. B. (2012). Ontologies and controlled vocabulary: comparison of building methodologies. In *Computer Engineering: Concepts, Methodologies, Tools and Applications* (pp. 46-60). IGI Global.

Dalmau Espert, J. L., Llorens Largo, F., & Molina-Carmona, R. (2015). An ontology for formalizing and automating the strategic planning process.

Daly, J. P. (1995). Explaining Changes to Employees: The Influence of Justifications and Change Outcomes on Employees' Fairness Judgments. *The Journal of applied behavioral science*, *31*(4), 415-428. https://doi.org/10.1177/0021886395314002

Dansereau, D. F., & Simpson, D. D. (2009). A Picture Is Worth a Thousand Words: The Case for Graphic Representations. *Professional psychology, research and practice*, *40*(1), 104-110. https://doi.org/10.1037/a0011827

Decker, P., Durand, R., Mayfield, C. O., McCormack, C., Skinner, D., & Perdue, G. (2012). Predicting implementation failure in organization change. *Journal of organizational culture, communication and conflict*, *16*(2), 39-60.

DeSanctis, G., & Poole, M. S. (1994). Capturing the Complexity in Advanced Technology Use: Adaptive Structuration Theory. *Organization science (Providence, R.I.)*, *5*(2), 121-147. https://doi.org/10.1287/orsc.5.2.121

Diamond, G. A. (1992). Field Theory and Rational Choice: A Lewinian Approach to Modeling Motivation. *Journal of social issues*, *48*(2), 79-94. https://doi.org/10.1111/j.1540-4560.1992.tb00885.x

Dobing, B., & Parsons, J. (2006). How UML is used. *Communications of the ACM*, *49*(5), 109-113. https://doi.org/10.1145/1125944.1125949

Dunnette, M. D., & Hough, L. M. (1992). *Handbook of industrial and organizational psychology, Vol. 3*. Consulting Psychologists Press.

Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of management review*, *14*(4), 532-550.

Evermann, J., & Wand, Y. (2005). Ontology based object-oriented domain modelling: fundamental concepts. *Requirements engineering*, *10*(2), 146-160. https://doi.org/10.1007/s00766-004-0208-2

Fakhroutdinov, K. (2009). *Activity Diagrams*. uml-diagrams.org. Retrieved June 2, 2020 from

Fakhroutdinov, K. (2009b). *UML Class and Object Diagrams Overview*. uml-diagrams.org. Retrieved June 2, 2020 from

Falbo, R. A., Quirino, G. K., Nardi, J. C., Barcellos, M. P., Guizzardi, G., Guarino, N., Longo, A., & Livieri, B. (2016). An ontology pattern language for service modeling. Proceedings of the 31st Annual ACM Symposium on Applied Computing,

Figl, K. (2017). Comprehension of Procedural Visual Business Process Models: A Literature Review. *Business & information systems engineering*, *59*(1), 41-67. https://doi.org/10.1007/s12599-016-0460-2

Figl, K., Mendling, J., & Strembeck, M. (2013). The influence of notational deficiencies on process model comprehension. *Journal of the Association for Information Systems*, *14*(6), 312-338. https://doi.org/10.17705/1jais.00335

Floyd, S. W., & Lane, P. J. (2000). Strategizing Throughout the Organization: Managing Role Conflict in Strategic Renewal. *The Academy of Management review*, *25*(1), 154-177. https://doi.org/10.5465/amr.2000.2791608

Frow, P., & Payne, A. (2011). A stakeholder perspective of the value proposition concept. *European journal of marketing*, *45*(1/2), 223-240. https://doi.org/10.1108/03090561111095676

Fuchs, S., & Prouska, R. (2014). Creating Positive Employee Change Evaluation: The Role of Different Levels of Organizational Support and Change Participation. *Journal of change management*, *14*(3), 361-383. https://doi.org/10.1080/14697017.2014.885460

Gargouri, F., & Jaziri, W. (2010). *Ontology Theory, Management and Design: Advanced Tools and Models*. Hershey: IGI Global. https://doi.org/10.4018/978-1-61520-859-3

Genon, N., Heymans, P., & Amyot, D. (2010). Analysing the cognitive effectiveness of the BPMN 2.0 visual notation. International conference on software language engineering, Berlin, Heidelberg.

Gioia, D. A., & Chittipeddi, K. (1991). Sensemaking and sensegiving in strategic change initiation. *Strategic management journal*, *12*(6), 433-448. https://doi.org/10.1002/smj.4250120604

Grant, R. M. (1991). The Resource-Based Theory of Competitive Advantage: Implications for Strategy Formulation. *California management review*, *33*(3), 114-135. https://doi.org/10.2307/41166664

Greenhalgh, T., Jackson, C., Shaw, S., & Janamian, T. (2016). Achieving Research Impact Through Co-creation in Community-Based Health Services: Literature Review and Case Study. *The Milbank quarterly*, *94*(2), 392-429. https://doi.org/10.1111/1468-0009.12197

Greenhalgh, T., & Stones, R. (2010). Theorising big IT programmes in healthcare: Strong structuration theory meets actor-network theory. *Social science & medicine (1982)*, *70*(9), 1285-1294. https://doi.org/10.1016/j.socscimed.2009.12.034

Greenhalgh, T., Stones, R., & Swinglehurst, D. (2014). Choose and Book: A sociological analysis of 'resistance' to an expert system. *Social science & medicine (1982)*, *104*, 210-219. https://doi.org/10.1016/j.socscimed.2013.12.014

Gregor, S., & Hevner, A. R. (2013). Positioning and Presenting Design Science Research for Maximum Impact. *MIS quarterly*, *37*(2), 337-355. https://doi.org/10.25300/misq/2013/37.2.01

Gregor, S., & Jones, D. (2007). The anatomy of a design theory.

Gregor, S., Kruse, L. C., & Seidel, S. (2020). The Anatomy of a Design Principle. *Journal of the Association for Information Systems*.

Guarino, N., Andersson, B., Johannesson, P., & Livieri, B. (2016). Towards an ontology of value ascription. Formal Ontology in Information Systems: Proceedings of the 9th International Conference (FOIS 2016),

Guizzardi, G., de Almeida Falbo, R., & Guizzardi, R. S. (2008). Grounding Software Domain Ontologies in the Unified Foundational Ontology (UFO): The case of the ODE Software Process Ontology. CIbSE,

Guizzardi, G., & Wagner, G. (2004). Towards ontological foundations for agent modelling concepts using the unified fundational ontology (UFO). International Bi-Conference Workshop on Agent-Oriented Information Systems,

Harmon, P. (2012). Scoping Processes. *BPTrends*, *10*(17).

Heinrich, C. J. (2002). Outcomes-Based Performance Management in the Public Sector: Implications for Government Accountability and Effectiveness. *Public administration review*, *62*(6), 712-725. https://doi.org/10.1111/1540-6210.00253

Hernes, T., Hendrup, E., & Schäffner, B. (2015). Sensing the Momentum: A Process View of Change in a Multinational Corporation. *Academy of Management Proceedings*, *2015*(1), 13570. https://doi.org/10.5465/ambpp.2015.13570abstract

Hevner, March, Park, & Ram. (2004). Design Science in Information Systems Research. *MIS quarterly*, *28*(1), 75-105. https://doi.org/10.2307/25148625

Hunt, S. T. (1996). Generic Work Behavior: An investigation into the dimensions of entry-level, hourly job performance. *Personnel psychology*, *49*(1), 51-83. https://doi.org/10.1111/j.1744-6570.1996.tb01791.x

Huy, Q. N. (2002). Emotional Balancing of Organizational Continuity and Radical Change: The Contribution of Middle Managers. *Administrative science quarterly*, *47*(1), 31-69. https://doi.org/10.2307/3094890

Johnson, M. W., Christensen, C. M., & Kagermann, H. (2008). Reinventing your business model. *Harvard business review*, *86*(12), 57-68.

Jones, L., Watson, B., Hobman, E., Bordia, P., Gallois, C., & Callan, V. J. (2008). Employee perceptions of organizational change: impact of hierarchical level. *Leadership & organization development journal*, *29*(4), 294-316. https://doi.org/10.1108/01437730810876122

Kaplan, S. (2011). Strategy and PowerPoint: An Inquiry into the Epistemic Culture and Machinery of Strategy Making. *Organization science (Providence, R.I.)*, *22*(2), 320-346. https://doi.org/10.1287/orsc.1100.0531

Kristof, A. L. (1996). Person-Organization Fit: An integrative review of its conceptualizations, measurement, and implications. *Personnel psychology*, *49*(1), 1-49. https://doi.org/10.1111/j.1744-6570.1996.tb01790.x

Larkin, J. H., & Simon, H. A. (1987). Why a Diagram is (Sometimes) Worth Ten Thousand Words. *Cognitive science*, *11*(1), 65-100. https://doi.org/10.1016/S0364-0213(87)80026-5

Lewin, K. (1945). The research center for group dynamics at Massachusetts Institute of Technology. *Sociometry*, *8*(2), 126-136.

Lewin, K. (1947). Frontiers in Group Dynamics: Concept, Method and Reality in Social Science; Social Equilibria and Social Change. *Human relations (New York)*, *1*(1), 5-41. https://doi.org/10.1177/001872674700100103

Lindquist, E. (2011). Surveying the world of visualization. *Australian National University*.

Lines, R. (2004). Influence of participation in strategic change: resistance, organizational commitment and change goal achievement. *Journal of change management*, *4*(3), 193-215. https://doi.org/10.1080/1469701042000221696

Lukyanenko, R., & Parsons, J. (2020). Design Theory Indeterminacy: What is it, how can it be reduced, and why did the polar bear drown? *Journal of the Association for Information Systems*.

Lüscher, L. S., & Lewis, M. W. (2008). Organizational Change and Managerial Sensemaking: Working Through Paradox. *Academy of Management journal*, *51*(2), 221-240. https://doi.org/10.5465/amj.2008.31767217

March, S. T., & Smith, G. F. (1995). Design and natural science research on information technology. *Decision Support Systems*, *15*(4), 251-266. https://doi.org/10.1016/0167-9236(94)00041-2

Markus, M. L., & Mao, J.-Y. (2004). Participation in Development and Implementation - Updating An Old, Tired Concept for Today's IS Contexts. *Journal of the Association for Information Systems*, *5*(11), 514-544. https://doi.org/10.17705/1jais.00057

Maté, A., Trujillo, J., & Mylopoulos, J. (2016b). Key performance indicator elicitation and selection through conceptual modelling. International Conference on Conceptual Modeling,

Mayer, R. E., & Moreno, R. (2003). Nine Ways to Reduce Cognitive Load in Multimedia Learning. *Educational psychologist*, *38*(1), 43-52. https://doi.org/10.1207/s15326985ep3801_6

McCurdy, N., Dykes, J., & Meyer, M. (2016). Action design research and visualization design. Proceedings of the Sixth Workshop on Beyond Time and Errors on Novel Evaluation Methods for Visualization,

McKenna, D. D., & Wright, P. M. (1992). Alternative metaphors for organization design. *Handbook of industrial and organizational psychology*, *3*, 901-960.

Miles, M. B. (1994). *Qualitative data analysis : an expanded sourcebook* (2nd ed.. ed.). Thousand Oaks : Sage Publications.

Miller, S. D., Duncan, B. L., Sorrell, R., & Brown, G. S. (2005). The partners for change outcome management system. *Journal of clinical psychology*, *61*(2), 199-208. https://doi.org/10.1002/jclp.20111

Moody, D. (2009). The "Physics" of Notations: Toward a Scientific Basis for Constructing Visual Notations in Software Engineering. *IEEE transactions on software engineering*, *35*(6), 756-779. https://doi.org/10.1109/TSE.2009.67

Moody, D. L., Heymans, P., & Matulevicius, R. (2010). Visual syntax does matter: Improving the cognitive effectiveness of the i visual notation. *Requirements engineering*, *15*(2), 141-175. https://doi.org/10.1007/s00766-010-0100-1

Mullarkey, M. T., & Hevner, A. R. (2019). An elaborated action design research process model. *European Journal of Information Systems*, *28*(1), 6-20.

Narayanan, V. K., Zane, L. J., & Kemmerer, B. (2011). The cognitive perspective in strategy: An integrative review. *Journal of Management*, *37*(1), 305-351.

Negri, P. P., Souza, V. E. S., de Castro Leal, A. L., de Almeida Falbo, R., & Guizzardi, G. (2017). Towards an Ontology of Goal-Oriented Requirements. CIbSE,

Orlikowski, W. J. (2000). Using Technology and Constituting Structures: A Practice Lens for Studying Technology in Organizations. *Organization science (Providence, R.I.)*, *11*(4), 404-428. https://doi.org/10.1287/orsc.11.4.404.14600

Orlikowski, W. J. (2002). Knowing in Practice: Enacting a Collective Capability in Distributed Organizing. *Organization science (Providence, R.I.)*, *13*(3), 249-273. https://doi.org/10.1287/orsc.13.3.249.2776

Osterwalder, A. (2004). *The business model ontology a proposition in a design science approach* Université de Lausanne, Faculté des hautes études commerciales].

Ottensooser, A., Fekete, A., Reijers, H. A., Mendling, J., & Menictas, C. (2012). Making sense of business process descriptions: An experimental comparison of graphical and textual notations. *The Journal of systems and software*, *85*(3), 596-606. https://doi.org/10.1016/j.jss.2011.09.023

Overkamp, T., & Ruijs, F. (2017). Involving stakeholders towards service implementation. Co-designing change of practices using a visual language. *The Design Journal*, *20*(sup1), S531-S549.

Palash, B., Pnina, S., & Jeffrey, P. (2019). Using Eye Tracking to Expose Cognitive Processes in Understanding Conceptual Models. *MIS quarterly*, *43*(4), 1105. https://doi.org/10.25300/MISQ/2019/14163

Paroutis, S., Franco, L. A., & Papadopoulos, T. (2015). Visual Interactions with Strategy Tools: Producing Strategic Knowledge in Workshops. *British journal of management*, *26*(1), S48-S66. https://doi.org/10.1111/1467-8551.12081

Parsons, J. (2003). Data Modeling. In J. Blazewicz, Kubiak, W., Morzy, T. and Rusinkiewicz, M. (Ed.), *Handbook on Data Management in Information Systems* (pp. 49-77). Springer.

Peffers, K., Tuunanen, T., Rothenberger, M. A., & Chatterjee, S. (2014). A Design Science Research Methodology for Information Systems Research. *Journal of management information systems*, *24*(3), 45-77. https://doi.org/10.2753/MIS0742-1222240302

Petrusel, R., Mendling, J., & Reijers, H. A. (2017). How visual cognition influences process model comprehension. *Decision Support Systems*, *96*(-), 1-16. https://doi.org/10.1016/j.dss.2017.01.005

Pierce, J. L., Kostova, T., & Dirks, K. T. (2001). Toward a Theory of Psychological Ownership in Organizations. *The Academy of Management review*, *26*(2), 298-310. https://doi.org/10.5465/amr.2001.4378028

Pinto, H. S., & Martins, J. P. (2004). Ontologies: How can They be Built? *Knowledge and information systems*, *6*(4), 441-464. https://doi.org/10.1007/s10115-003-0138-1

Pissierssens, S., Claes, J., & Poels, G. (2019). The "Physics of Diagrams": Revealing the scientific basis of graphical representation design.

Popescu, G., & Wegmann, A. (2014). Using the physics of notations theory to evaluate the visual notation of seam. 2014 IEEE 16th Conference on Business Informatics,

Recker, Rosemann, Green, & Indulska. (2011). Do Ontological Deficiencies in Modeling Grammars Matter? *MIS quarterly*, *35*(1), 57-79. https://doi.org/10.2307/23043489

Ross, J. W., Beath, C. M., & Mocker, M. (2019). Creating Digital Offerings Customers Will Buy. *MIT Sloan management review*, *61*(1), 64-69.

Sales, T. P., Guarino, N., Guizzardi, G., & Mylopoulos, J. (2017). An ontological analysis of value propositions. 2017 IEEE 21st International Enterprise Distributed Object Computing Conference (EDOC),

Sassen, E. J. (2009). Love, Hate, or Indifference: How Nurses Really Feel About the Electronic Health Record System. *Computers, informatics, nursing*, *27*(5), 281-287. https://doi.org/10.1097/NCN.0b013e3181b2162a

Schein, E. H., & Schein, P. A. (2016). *Organizational culture and leadership*. ProQuest Ebook Central https://ebookcentral-proquest-com.qe2a-proxy.mun.ca

Sein, Henfridsson, Purao, Rossi, & Lindgren. (2011). Action Design Research. *MIS quarterly*, *35*(1), 37-56. https://doi.org/10.2307/23043488

Sein, M. K., & Rossi, M. (2019). Elaborating ADR while drifting away from its essence: A commentary on Mullarkey and Hevner. *European Journal of Information Systems*, *28*(1), 21-25.

Seligman, L. (2006). Sensemaking throughout adoption and the innovation-decision process. *European Journal of Innovation Management*, *9*(1), 108-120. https://doi.org/10.1108/14601060610640050

Shah, S. G. S., & Robinson, I. (2007). Benefits of and barriers to involving users in medical device technology development and evaluation. *International journal of technology assessment in health care*, *23*(1), 131-137. https://doi.org/10.1017/S0266462307051677

Shannon, C., & Weaver, W. (1963). *The Classical Theory of Communication*. University of Illinois Press.

Sonenshein, S., & Dholakia, U. (2012). Explaining Employee Engagement with Strategic Change Implementation: A Meaning-Making Approach. *Organization science (Providence, R.I.)*, *23*(1), 1-23. https://doi.org/10.1287/orsc.1110.0651

Steen, M., Manschot, M. A. J., & De Koning, N. (2011). Benefits of co-design in service design projects. *International journal of design*, *5*(2), 53-60.

Stewart, A. (1998). *Ethnographer's Method*. Los Angeles: SAGE Publications Inc.

Stones, R. (2005). *Structuration Theory*. London : Macmillan Education UK : Imprint: Palgrave.

Störrle, H., & Fish, A. (2013a). Towards an Operationalization of the "Physics of Notations" for the Analysis of Visual Languages. International Conference on Model Driven Engineering Languages and Systems, Berlin, Heidelberg.

Sweller, J., & Chandler, P. (1991). Evidence for cognitive load theory. *Cognition and instruction*, *8*(4), 351-362.

Tushman, M. L., & O'Reilly, C. A. (1996). Ambidextrous Organizations: Managing Evolutionary and Revolutionary Change. *California management review*, *38*(4), 8-29. https://doi.org/10.2307/41165852

Uschold, M. (1996). Building ontologies: Towards a uni ed methodology. Proceedings of 16th Annual Conference of the British Computer Society Specialists Group on Expert Systems,

Uschold, M., & Gruninger, M. (1996). Ontologies: principles, methods and applications. *Knowledge engineering review*, *11*(2), 93-136. https://doi.org/10.1017/S0269888900007797

Venable, J., Pries-Heje, J., & Baskerville, R. (2016). FEDS: a Framework for Evaluation in Design Science Research. *European journal of information systems*, *25*(1), 77-89. https://doi.org/10.1057/ejis.2014.36

Volberda, H. W., Foss, N. J., & Lyles, M. A. (2010). Perspective—Absorbing the concept of absorptive capacity: How to realize its potential in the organization field. *Organization science*, *21*(4), 931-951.

Vrhovec, S. L., Hovelja, T., Vavpotič, D., & Krisper, M. (2015). Diagnosing organizational risks in software projects: Stakeholder resistance. *International journal of project management*, *33*(6), 1262-1273.

Wand, Y., & Weber, R. (2002). Research Commentary: Information Systems and Conceptual Modeling--A Research Agenda. *Information Systems Research*, *13*(4), 363-376. https://doi.org/10.1287/isre.13.4.363.69

Weick, K. E., Sutcliffe, K. M., & Obstfeld, D. (2005). Organizing and the process of sensemaking. *Organization science*, *16*(4), 409-421.

Weisbord, M. R. (1976). Organizational Diagnosis: Six Places To Look for Trouble with or Without a Theory. *Group & organization studies*, *1*(4), 430-447. https://doi.org/10.1177/105960117600100405

White, S. (2004). Introduction to BPMN.

Zave, P., & Jackson, M. (1997). Four dark corners of requirements engineering. *ACM Transactions on Software Engineering and Methodology (TOSEM)*, *6*(1), 1-30. https://doi.org/10.1145/237432.237434

Zott, C., & Amit, R. (2010). Business Model Design: An Activity System Perspective. *Long range planning*, *43*(2-3), 216-226. https://doi.org/10.1016/j.lrp.2009.07.004

APPENDICES

Appendix A: Observation Recording Template for Intervention Three

Research Workshop Observations

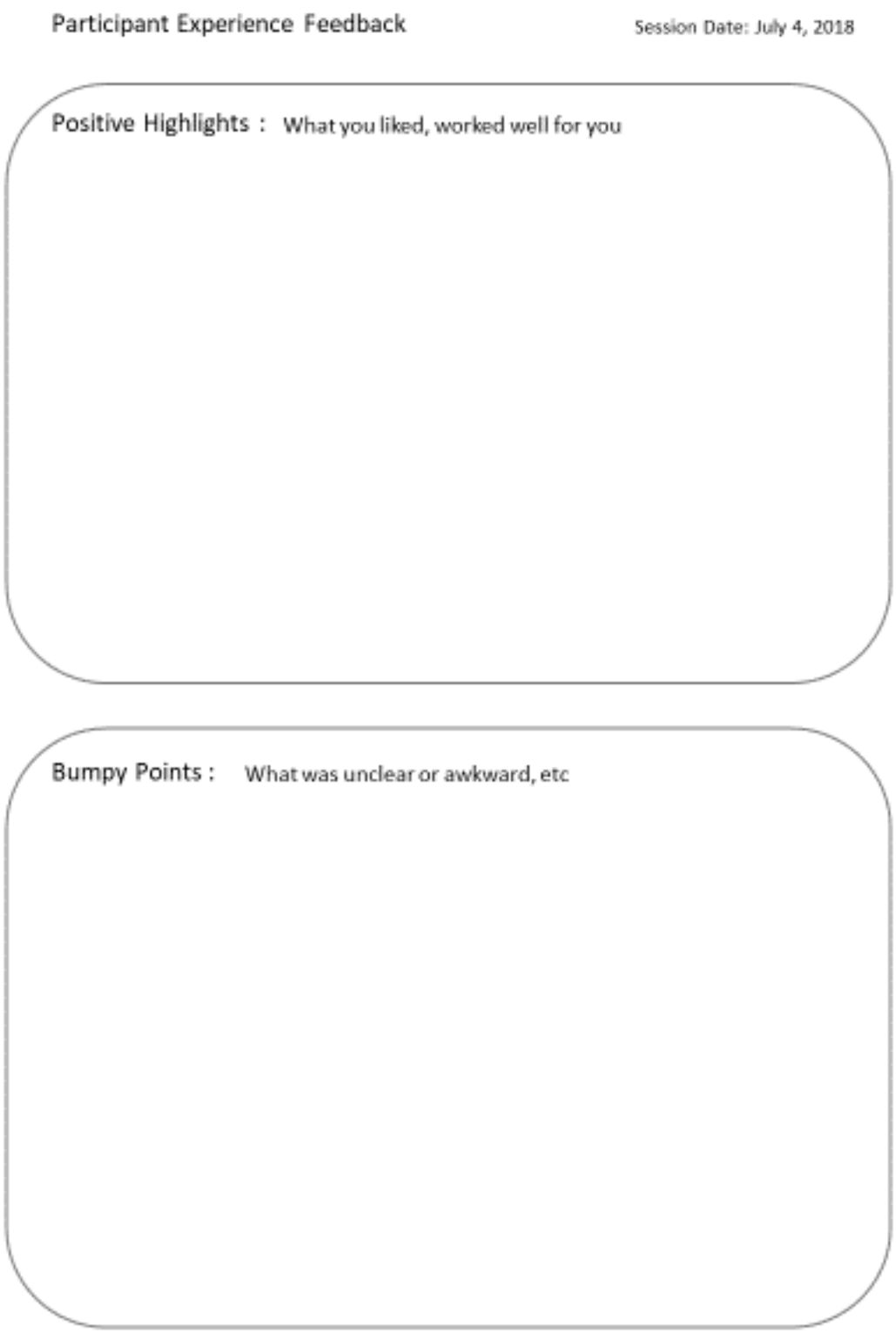
Observer: **Date**:

Things to observe:

- How people are reacting (e.g. body language, tone of voice, level/type of contribution)
- How people are interacting with the visual tools
- How people are interacting with each other
- Significant quotes from participant discourse reflecting engagement in the discussion

Observations:

Appendix B: Participant Feedback Sheet for Intervention Three



Appendix C: Stakeholder Icon Image Search on Google and Bing

Appendix D: Goal Icon Image Search on Google and Bing

Appendix E: Risk Icon Image Search on Google and Bing