

Applying Qualitative System Dynamics to Enhance Performance Measurement for a
Sustainable Health System in British Columbia

by

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BSc, University of Victoria, 2007

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of

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in the School of Health Information Science

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Abstract

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The current approach to performance measurement in British Columbia is to select and match performance measures with strategic goals and objectives so that health administrators and decision makers can evaluate the performance of different care sectors (e.g. primary, community and acute care) within the provincial health system. Although this approach offers basic understanding of system performance, it is static and considers the performance of organizational components in isolation from their interrelationships and external influences. The purpose of this research is to enhance the current performance measurement approach in BC by linking health system variables through causal relationships and feedback loops that can impact and lead to health system sustainability. The qualitative system dynamics method was applied to develop a conceptual performance measurement model. Fifteen interviews with stakeholders were conducted at the BC Ministry of Health to validate and improve the pre-validation model. A post-validation model was then created based on the feedback and comments from the 15 interview participants. As a product of this research, the post-validation model, *Web of Measures 2.0*, will explain how the identified cause and feedback mechanisms both internal and external to the BC health system may help determine policy levers for designing and developing quality improvement initiatives. Although quantitative analysis is out of scope for this research, potential benefits of inputting BC data into the proposed model are discussed at the end of this thesis.

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Dedication

To my dear wife, Anya

And

Our children, Serena and Griffin

Without you

This would be impossible

Glossary

First generation performance measurement systems

The first generation performance measurement systems supplement the traditional financial measures with non-financial and often intangible measures. The first generation performance measurement systems provide a broader perspective on organizational performance and further identify the importance of linking and integrating performance measures (Neely et al., 2003).

Mental model

Mental models are conceptual interpretations of the system. They can be used to describe the system structure and further explain system behaviours (Forrester, 1961; Sterman, 2000; Wolstenholme, 1990).

Performance measure & Performance indicator

Performance measure is a quantitative tool, such as rate, ratio, or percent, which provides an indication of an organization's performance in relation to a specified process or outcome.

Performance indicator is a marker or sign of things that need to be measured but which may not be directly, fully, or easily measured.

Despite the difference, the terms performance measure and performance indicator are used interchangeably in most general discussions about performance measurement (Adair et al., 2006).

Performance measurement

The process of monitoring, evaluating, and communicating the performance of an individual, organization, or system against their key objectives (Smith et al., 2010).

Qualitative System Dynamics

The qualitative system dynamics method is used to create and examine feedback loop structure of systems using resource flows, represented by level and rate variables and information flows, represented by auxiliary variables; to provide a qualitative assessment of the relationship between system processes (including delays), information, organizational boundaries and strategy; and to estimate system behaviour and to postulate strategy design changes to improve behaviour (Wolstenholme, 1990).

Second generation performance measurement systems

The second generation performance measurement systems provide a significant improvement in measurement due to their abilities to realize the dynamics of value creation, link system variables together across performance dimensions, and visualize the linkage between financial assets and business value with a conceptual framework, map, or model (Neely et al., 2003).

Sustainability & Sustainable development

Sustainability is the ability to ensure that sufficient resources are available over the long term to provide timely access to quality services that address Canadians' evolving health needs (Romanow, 2002).

Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland, 1987).

In the health system context, the understanding of sustainability and sustainable development is the same; therefore, the two terms are used interchangeably in this thesis.

Sustainable Health and Health Care

The appropriate balance between the cultural, social, and economic environments designed to meet the health and health care needs of individuals and the population (from health promotion and disease prevention to restoring health and supporting end of life) and that leads to optimal health and health care outcomes without compromising the outcomes and ability of future generations to meet their own health and health care needs (The Conference Board of Canada, 2014).

System

A set of elements standing in interaction (Bertalanffy, 1968). These interactions among system elements form patterns of behaviour, which create events that external parties can observe (Kirkwood, 1998).

System Dynamics

A rigorous method for qualitative description, exploration and analysis of complex systems in terms of their processes, information, organisational boundaries and strategies; which facilitates quantitative simulation modelling and analysis for the design of system structure and control (Wolstenholme, 1990).

Chapter 1 Introduction

This chapter first describes the context of the research including an overview of health expenditures in British Columbia (BC), issues relating to health system sustainability, and the actions undertaken by BC in response to population and patient health needs; second, the research purpose and questions are stated; and third, the research processes and thesis structure are outlined.

1.1 Background

1.1.1 Health Expenditures

Despite the recent stagnation in the growth of health spending among Organisation for Economic Co-operation and Development (OECD) countries, health expenditure continues to consume a large portion of national budgets in the developed world (OECD, 2013). The Canadian Institute for Health Information (CIHI) reported that Canadian health spending has reached \$215 billion in 2014; that is a 119 percent increase from 2000 (\$98 billion) (CIHI, 2014).

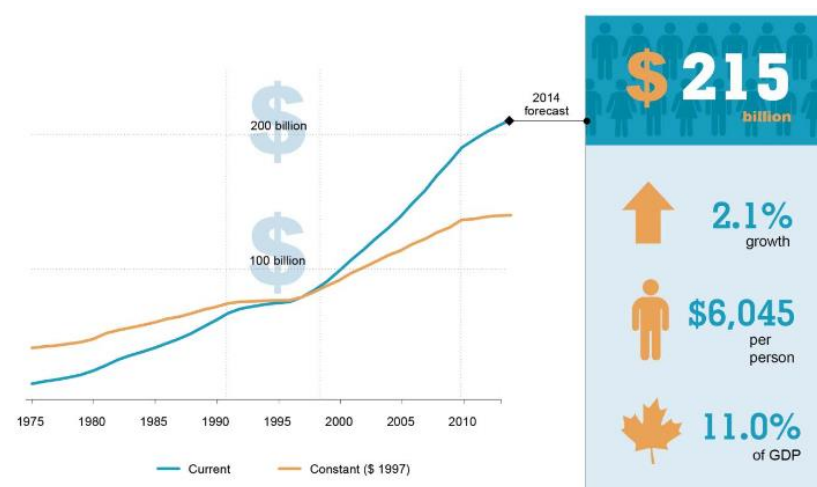


Figure 1: Infographic on Health Spending in Canada in 2014 (CIHI, 2014)

When compared to other OECD countries, in 2012 Canada ranks seventh based on health spending as a percent of its Gross Domestic Product (GDP) at 10.9 percent, behind the United States (US), the Netherlands, France, Switzerland, Germany, and Denmark (OECD, 2014). In 2012, Canada spent \$4,602 per person in health care behind the US, Norway, Switzerland, the Netherlands, Germany, and Denmark (OECD, 2014). More recent data from CIHI indicate that in 2014, spending increased to \$6,045¹ per person (CIHI, 2014). Figure 2 (below) summarizes 2012 OECD data.

How does Canada compare?



Figure 2: Infographic of Health Expenditure Data among OECD Countries in 2012 (CIHI, 2014)

Health care is the largest public expenditure in BC: the health operating expenditure grew from \$8.7 billion in fiscal year (FY) 2000/2001 to \$16.6 billion in FY 2013/2014 (BC Ministry of Health, 2014c).

¹ CIHI reports in Canadian dollars, where OECD reports in US dollars.

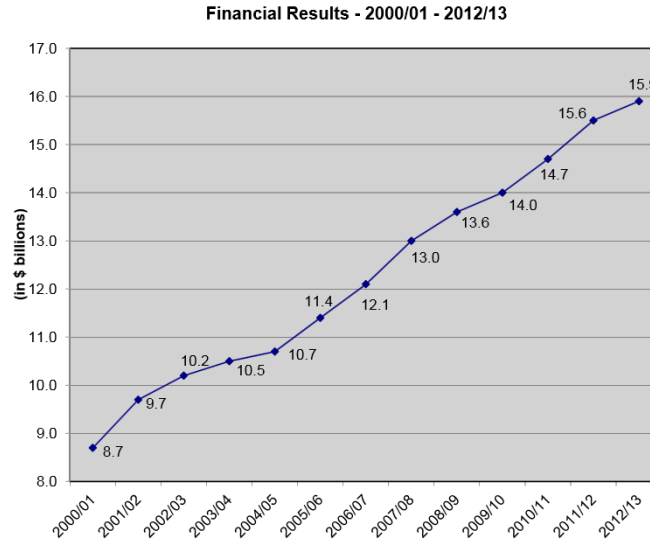


Figure 3: Skyrocketing Increase of Health Budget in BC (BC Ministry of Health, 2013a)

When compared to other Canadian provinces, BC at 43 percent, ranks third place based on health expenditure as a percent of the provincial operating budget, behind Nova Scotia (46%) and Manitoba (44%) (see Figure 4).

How do the provinces and territories compare?

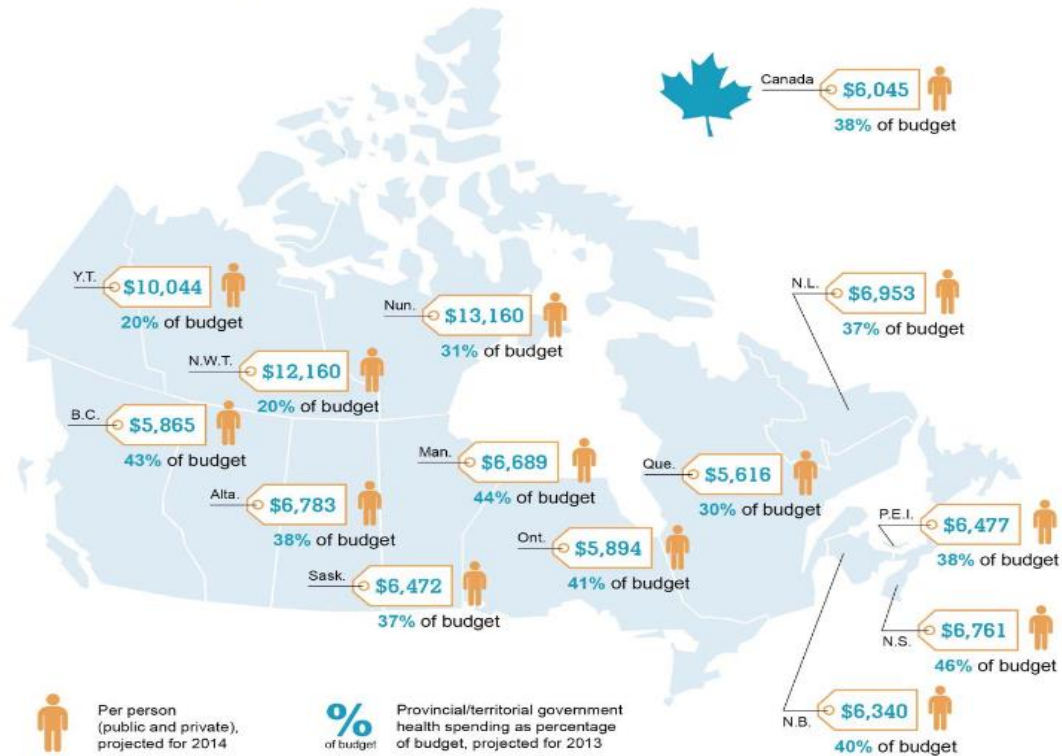


Figure 4: Canadian Provincial Health Spending Statistics (CIHI, 2014)

BC Ministry of Finance forecasts that the total government expense will be \$45.8 billion (BC Ministry of Finance, 2015a, p. 1) and total health spending will reach \$17.4 billion (BC Ministry of Finance, 2015b, p. 6) by FY 2015/2016. These statistics show that the BC government may reduce health spending, as a proportion of the provincial budget, from 43 percent in 2012 to 38 percent ($17.4 / 45.8 * 100$) in 2015. If the 2.5 percent annual increase in government expense continues for the next 10 years and the 5.2 percent² annual increase in health spending persists for another decade, by 2025 the BC government total expense will be at around \$58.6 billion and total BC health expenditure will be at \$28.8 billion. That is almost half (49%) of the entire provincial budget! Under this assumption, if health spending is not controlled, other publicly funded services such as education and transportation will have to be reduced or eliminated to sustain health services. BC needs to change the way health care is organized and delivered and control health care costs to ensure other publicly funded services receive adequate funding. Consequently, a priority is to have a sustainable health system in BC.

1.1.2 Health System Sustainability

Sustainability in a health system context is often referred to as the ability to meet the needs of future generations without compromising the needs of current generations (Faezipour et al., 2013). In the *Building on Values – The Future of Health Care in Canada*, Roy Romanow defined sustainability as the ability to ensure that “sufficient resources are available over the long term to provide timely access to quality services that address Canadians’ evolving health needs” (Romanow, 2002, p. 1). While discussions on health system sustainability are often linked to affordability or the ratio of expenditure growth and economic growth, it is increasingly apparent

² The 5.2% annual increase is calculated from FY2000/2001 to FY2012/2013 as indicated in Figure 3.

that social and environmental dimensions also need to be considered. For achieving and maintaining health system sustainability, a multi-faceted, systems approach is required to manage internal variables as well as variables that are external and influence the system. Internal health system variables include health policies, care providers, and service provisions; external health system variables include socioeconomic status and determinants of health such as income, education, housing, and social support.

In the 2014 Ministry of Health Service Plan, BC Health Minister Terry Lake stated three goals: support the health and wellbeing of residents of BC; deliver a system of responsive and effective health care services across BC; and ensure value for money. One of the objectives under Goal 3 states, “[driving] budget management, efficiency, collaboration and quality improvement to ensure sustainability of the publicly funded health system” (BC Ministry of Health, 2014a, p. 17). To maintain a sustainable health system, eight priority areas for delivering health services are identified in the BC Health System Strategy and are outlined in the next section.

1.1.3 Health System Strategy

An accompanying document to the 2014/2015 – 2016/2017 Service Plan is the BC Health System Strategy: *Setting Priorities for the B.C. Health System*. To support the Balanced Budget 2014, the BC Ministry of Health published the strategy in February 2014. Deputy Minister Stephen Brown stated that this strategy aims to control spending through ensuring a sustainable, high quality health system to produce desired health outcomes. This strategic direction will guide the Ministry for the next three years in support of achieving its organizational goals and related priorities (BC Ministry of Health, 2014b).

The Health System Strategy is based on the apparent success of the Innovation and Change Agenda (see Figure 5), which was the Ministry's strategic framework from 2009 to 2013. The strategies were organized under four key themes:

1. Provide effective health promotion, prevention and self-management to improve the health and wellness of British Columbians;
2. Meet the majority of health needs with high quality primary and community based health care and support services;
3. Ensure high quality hospital care services are available when needed; and
4. Improve innovation, productivity and efficiency in the delivery of health services (Grant, 2013).

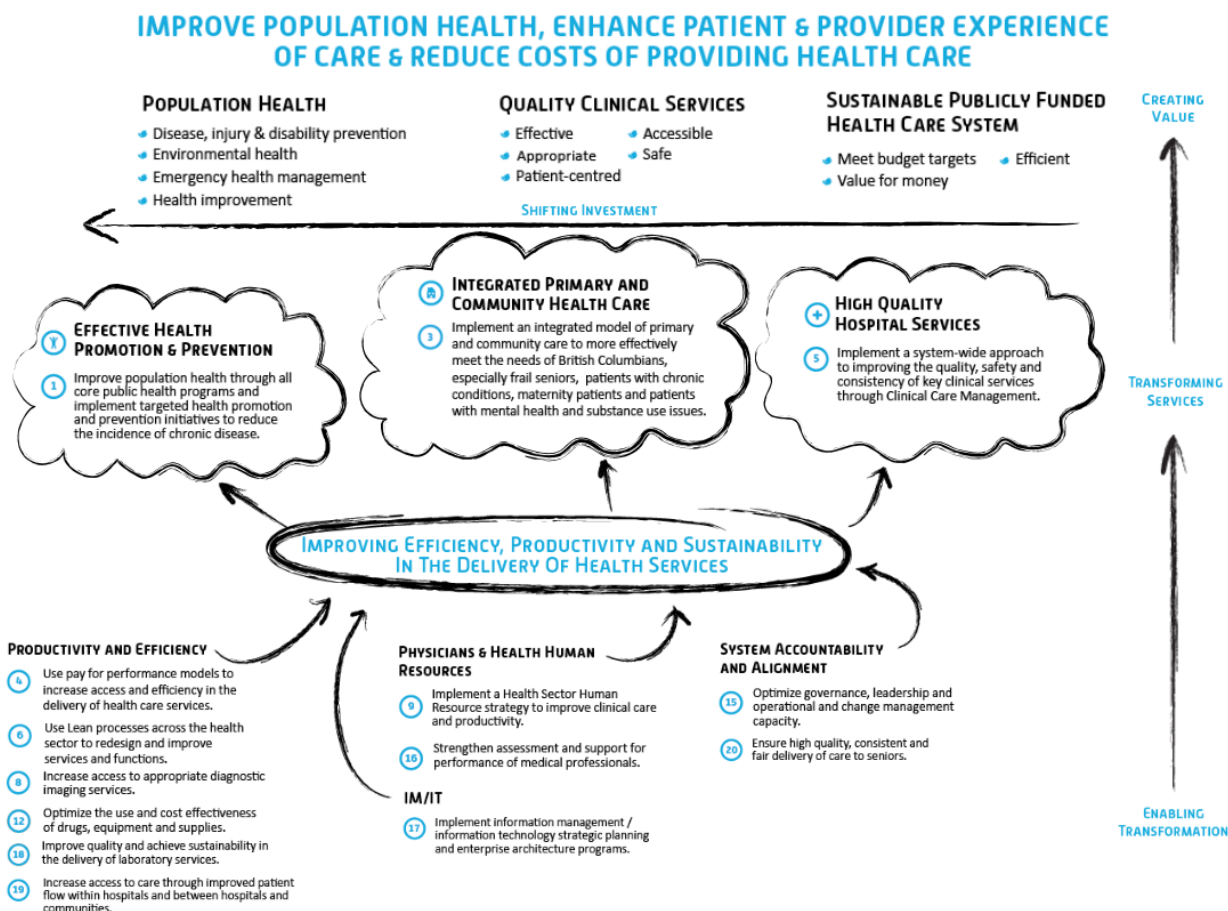


Figure 5: BC's Innovation and Change Agenda, 2009-2013 (Davidson, 2013)

The Health System Strategy is less specific and focuses on the following three areas:

1. Outcomes – What outcomes do we want to achieve in terms of the health of populations and patients? Which populations and patients require prioritized attention?
2. Sustainability – What kind of sustainable health service delivery system do we need to have in place to meet those outcomes, and at what level of quality?
3. Strategy – What enabling strategy will we pursue to get results? What enabling factors do we need to leverage and what constraints do we need to mitigate (BC Ministry of Health, 2014b)?

In response to the outcomes-, sustainability-, and strategy-related questions, six improvement areas, eight priorities, and seven enabling strategies are proposed in the BC Health System Strategy.

- The six improvement areas are intended to address the first strategic area, “outcomes.” These aims will address efforts to improve patient care and outcomes for prioritized populations, drive a sustainable budget, and potentially free up funds to better meet other patient needs in the health system.
- The eight priorities respond to the second strategic area, “sustainability.” These priorities are to support the improved outcomes and acknowledge the efforts BC needs to make for a sustainable health service delivery system.
- The seven enabling strategies are related to the third area, “strategy.” These strategies promote a collaborative and strategic approach to change management based on the realities BC health system is facing.

[Appendix A](#) includes the complete list of all six improvement areas, eight priorities, and seven enabling strategies. Figure 6 is a pictorial summary of the goals, priorities, and enabling strategies outlined in the strategy.

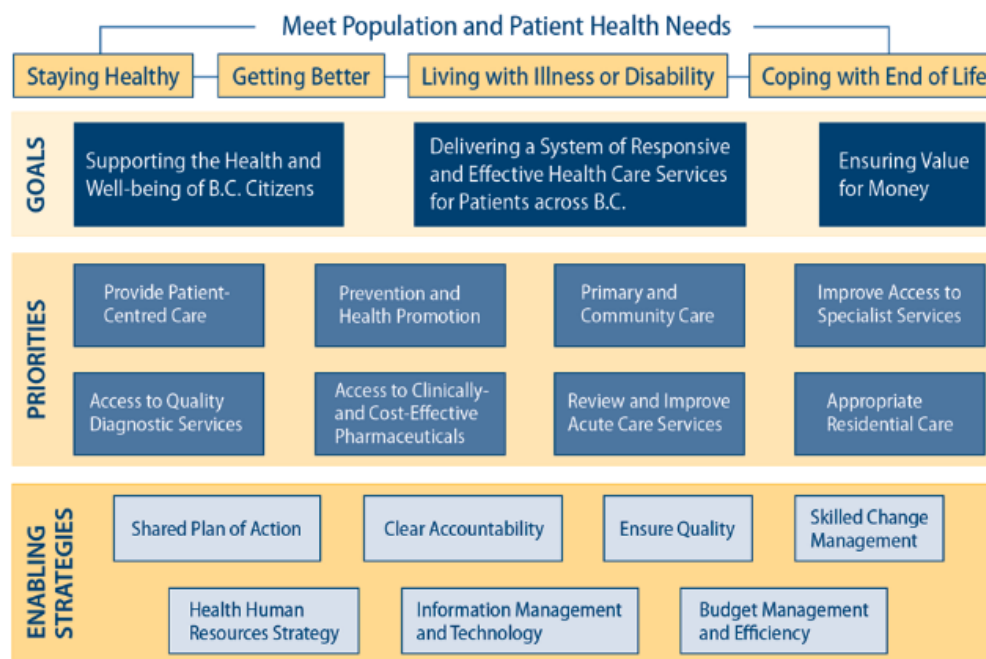


Figure 6: Health Strategy Map for the BC Health System (BC Ministry of Health, 2014b)

1.1.4 Health System Performance

Health system strategies present an overarching plan for the health system to provide quality services and maintain sustainability (Smith et al., 2010). An accountability framework is necessary to measure health system performance and ensure that the goals and priorities of the system are achieved using well-implemented strategies. Performance measurement offers policy and decision makers opportunities for engaging health system improvement and accountability.

This research uses data from two Canadian performance measurement frameworks: CIHI's performance measurement framework that measures health system performance nationally, and Alberta's health system outcomes and measurement framework that measures health system performance throughout a province. The Federal Government and most provinces use the domain-based approach to categorize performance areas. These performance measurement frameworks, along with the performance information collected from the

performance indicators, provide benchmarks for health system improvement and assist with trend analysis.

1.2 Motivation for the Development of Performance Measures

Strategy 2 in the Health System Strategy, accountability to deliver the three-year plan, points to the need for a clear performance management accountability framework. This framework will be used by the Ministry of Health and BC health authorities to assess and monitor their respective health system. The perceived effectiveness of this framework will be based on data organized around indicators which, in turn, comprise performance measures. The indicators (and more broad performance measures) will be used to measure and monitor the eight priorities and seven strategies.

The Ministry of Health Service Plan for FY 2014/2015 to 2016/2017 outlines the Ministry's goals, objectives, and performance measures which function to ensure maximum value for taxpayers and maximum benefit to patients (BC Ministry of Health, 2014a). Table 1 includes Ministry Service Plan's goals, objectives, and performance measures.

Goals	Objectives	Performance Measures
1. Support the health and wellbeing of British Columbians.	1.1 Targeted and effective primary prevention and health promotion.	<i>Healthy communities:</i> Percent of communities (out of 162) that have completed healthy living strategic plans.
2. Deliver a system of responsive and effective health care services across British Columbia.	2.1 A provincial system of primary and community care built around inter-professional teams and functions.	<i>Access to full service primary care:</i> Percent of family physicians participating in the "A GP for me" full service family practice initiative.
	2.2 Strengthened interface between primary and specialist care and treatment.	
	2.3 Timely access to quality diagnostics.	<i>Chronic disease hospital admissions:</i> Number of people under 75 years with a chronic disease admitted to hospital

	2.4 Renewed role of hospitals in the regional health care continuum.	(per 100,000 people aged less than 75 years).
	2.5 Increased access to an appropriate continuum of residential care services.	<i>Access to non-emergency surgery: Per cent of non-emergency surgeries completed within 26 weeks</i>
3. Ensure value for money	3.1 Evidence-informed access to clinically effective and cost-effective pharmaceuticals	
	3.2 Align workforce, infrastructure, information management and technology resources to achieve patient and service outcomes.	
	3.3 Drive budget management, efficiency, collaboration, and quality improvement to ensure sustainability of the publicly funded health system.	

Table 1: Ministry Service Plan Goals, Objectives, and Performance Measures (BC MoH, 2014a)

The data used to measure system performance are updated annually by program areas within the BC Ministry of Health and the health authorities within BC. The four performance measures in the above table are for FY 2014/2015. They purport to inform the Ministry on how accessible and effective health care services are to residents of BC.

The FY 2014/2015 Service Plan states, “In the coming year the Ministry and its health system partners will develop a broader suite of performance measures and reporting mechanisms closely aligned with the goals and objectives” (BC Ministry of Health, 2014b, p. 10). Even though BC has a strong strategy to steer the health system to attain its outcomes, having appropriate performance indicators to measure the success of this strategy is vital. The commitment from the Ministry to measure BC health system performance motivates the present research to review, compare, and discover suitable performance measures for BC. This effort

will build on the current Ministry Service Plan measures as well as Health Authority Service Plan measures.

1.3 Research Purpose and Questions

This research is about the development of a performance measurement model that may contribute to the sustainability of the BC health system. More specifically, this research will:

1. **Identify health system macro-level variables:** identify structural-level variables that impact the sustainability of the BC health system. It shows that linking BC health system variables through causal relationships and feedback loops may assist in developing a more effective performance measurement model;
2. **Develop a model of performance measures:** develop a performance measurement model based on qualitative system dynamics which may assist in developing a sustainable BC health system; and
3. **Validate:** validate and improve the developed system dynamics based performance measurement model with stakeholder interviews.

This research will answer the following three questions:

1. What are the structural-level variables and their interrelationships of the BC health system that impact sustainability?
2. What is the explanation behind these interrelationships among system variables and how can policy levers be identified to achieve health system sustainability?
3. How can the proposed model assist in BC's performance measurement practices for a sustainable health system?

1.4 Outline of Thesis

This research uses the qualitative system dynamics method to develop a model of performance measures. The system dynamics method helps analysts to understand the dynamic system behaviours caused by the complex structure and existing policies, realize why low-leverage policies will fail, and assist decision makers to develop stronger policies (Forrester, 2007). This thesis follows the two-phase approach published in the qualitative system dynamics method by Wolstenholme (1990). The outcome of this research will be a qualitative performance measurement model containing performance-related variables and their interrelationships for the BC health system. The proposed performance measurement model may be adopted by the BC Ministry of Health to measure, monitor, and report on the performance of the provincial health system against its strategic goals, priorities, and objectives.

The next four chapters of this thesis are organized as follows:

- **Chapter Two** summarizes some key literature on health system sustainability, system performance measurement, and systems theory;
- **Chapter Three** outlines the 10-step methodology used to conduct this research;
- **Chapter Four** explains how the qualitative system dynamics method is used to describe the current state of performance measurement in BC, design and validate the pre-validation performance measurement model, and propose the post-validation model to enhance performance measurement practices in BC;
- **Chapter Five** examines how the post-validation model is benefited from the learning points through the literature review, discusses how research questions are addressed, and describes research limitations and opportunities for future research; and
- **Chapter Six** concludes this thesis with an overview of the highlights of this research.

Figure 7 (below) is a diagrammatic representation of the research process:

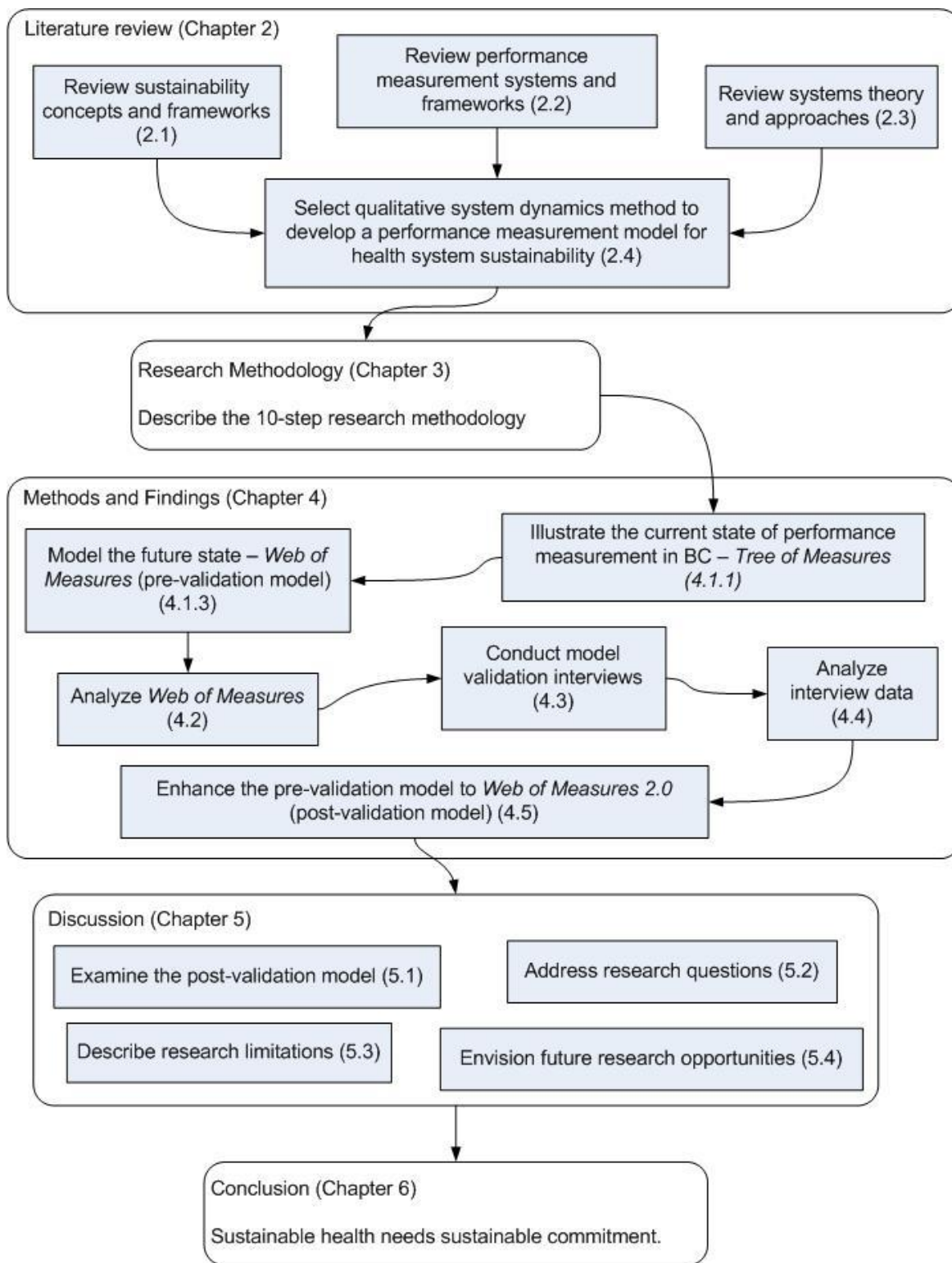


Figure 7: An Outline of the Research Process

Chapter 2 Literature Review

Chapter Two reviews the three focus areas of this research: 1) health system sustainability, 2) health system performance measurement, and 3) system dynamics. The literature review highlights the concept of sustainability and its application to health system performance measurement. The review of the concept of sustainability assists this research to develop a sustainable health service delivery model. Various performance measurement frameworks at the national and provincial levels are reviewed: the CIHI health system performance measurement framework is used as an example of a pan-Canadian system measurement framework; the Alberta Health Services' health system outcomes and measurement framework is selected as a provincial example because it is the province that most closely aligns their provincial performance measures with CIHI's national performance measures. This chapter concludes with an overview of the systems (or functionalist) perspective and a discussion of how a system dynamics approach compares to other systems approaches.

2.1 Health System Sustainability

2.1.1 *The Concept of Sustainability*

Although the concept of sustainability was embodied in the history of the Iroquois people (Heinberg, 2010) and in 1713 by the German forester and scientist Hans Carl von Carlowitz, it was not until 1987 when the Brundtland Report from the United Nation's World Commission on Environment and Development published the global agreement on sustainable development that the concept of sustainability gained world-wide attention (Brundtland, 1987).

The Brundtland Report describes sustainable development as “development that meets the needs of the present [generation] without compromising the ability of future generations to

meet their own needs” (Brundtland, 1987, p. 41). This definition emphasizes the contradiction between limited resources and the growth of technology and energy consumption. The Brundtland Report urges nations to adopt strategic imperatives to move from their destructive present to sustainable development paths. Countries’ policy changes would need to be considered with respect both to their own development and to their impacts on other nations. The Brundtland Report concluded with strategies for sustainable development aimed to promote harmony among people from different nations and between humanity and nature. In the broadest sense, the pursuit of sustainable development requires the following seven strategies:

1. A political system that secures effective citizen participation in decision making;
2. A social system that offers solutions for the tensions arising from disharmonious development;
3. A technological system that inquires continuously for new solutions;
4. An economic system that is capable to generate surpluses and knowledge on a self-reliant and sustained basis;
5. A production system that preserves the ecological base for further development;
6. An international system that fosters sustainable patterns of trade and finance; and
7. An administrative system that provides flexibility and is able to self-correct (Brundtland, 1987).

These strategies highlight the lesson that policy development on sustainability issues needs to consider multiple systems and their interrelationships with each other.

Dillard et al. (2009) conceptualized sustainability in terms of development and is comprised of three mutually exclusive, but yet dependent dimensions: environmental, social, and economic. Environmental sustainability pertains to natural and renewable resources, social sustainability refers to societal members having basic needs met, and economic sustainability is developments in environmental and social sustainability being financially feasible. These three dimensions are referred to as the three pillars of sustainability (see Figure 8).

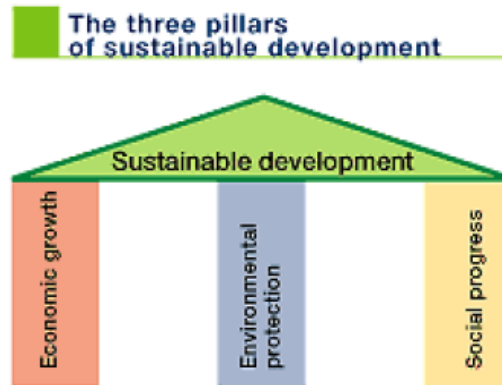


Figure 8: The Three Pillars of Sustainability (Adams, 2006)

The economic pillar ensures fair distribution and efficient allocation of resources with the aim to ease demands from high consumption lifestyles. Economic sustainability promotes a healthy balance with the ecosystem in fast economic growth. The environmental pillar protects limited resources from corporate exploitation and neglect. This pillar supports initiatives such as renewable energy, reducing fossil fuel consumption and emissions, sustainable agriculture and fishing, reducing deforestation, and better waste management. The social pillar addresses problems like inequality, social injustice, and poverty. It engages with programs that encompass areas such as social equality, social justice, and reducing poverty (Yadadrop, 2014).

In the report *The Future of Sustainability: Re-thinking Environment and Development in the Twenty-first Century*, Adams (2006) points out that the success of economic sustainability depends on the stability of social sustainability, which is constrained by the limitations of environmental sustainability. This interdependent relationship can be drawn as a concentric circle diagram shown in Figure 9. Adams explains that the model of three pillars supporting sustainable development individually was no longer adequate. The problem of the environmental degradation was commonly accompanied by economic growth, and yet such growth was needed to alleviate poverty.

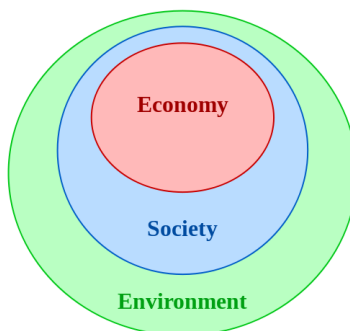


Figure 9: The Interdependent Relationship of the Three Sustainability Pillars (Adams, 2006)

Adams (2006) also states that the three pillars of sustainability are unique, interdependent, and interrelated. Adams argues the three objectives need to be better integrated to properly address the balance between dimensions of sustainability. By using a series of interlocking circles, Figure 10 shows that the environmental pillar needs to be integrated within the economic and social pillars when government funded programs are implemented.



The three pillars of sustainable development, from left to right, the theory, the reality and the change needed to better balance the model

Figure 10: The Interrelated Relationships among the Three Pillars (Adams, 2006)

Pappas (2012) states that it is essential for disciplines to be aware of sustainability from a systems approach, and believes that sustainability must address more than environmental resources. Pappas developed a model of sustainability that includes the three pillars of sustainability and adds two other dimensions: technical and individual. Technical Sustainability

refers to mechanical and technical factors such as scientific research to support sustainable product design, technological development for efficient and durable constructions, and smart selection of materials and disposal of both used and unused materials. Individual Sustainability refers to individuals living a sustainable lifestyle which consists of creating harmony, interconnection, and awareness of one's values, beliefs, and behaviours in disciplining one's physical, emotional, social, environmental, philosophical, and intellectual life (Pappas, 2012). According to Pappas, all five contexts of sustainability are necessary for a society to survive, prosper, and ensure and improve quality of life for its people.

A commonality across the seven strategies for sustainable development, the three pillars of sustainability, and the five contexts of sustainability is that by targeting one specific sector or managing sectors individually will fail to lead to sustainability. To achieve sustainability, organizations have to recognize the interrelationships among all organizational elements such as people, processes, structures, supplies, demands, and outcomes. Managing the interrelationships is critical for creating and maintaining sustainability. The conceptualizations of sustainability share a common, holistic way of interpreting complex and ill-defined problems:

- The Brundtland Report's seven strategies for sustainable development raises the importance of including environment and economics in decision making so that interconnected systems and subsystems can be managed together.
- The evolution of the three pillars of sustainability highlights how the three pillars can simultaneously influence each other and be interdependent of one another.
- Pappas's five contexts of sustainability emphasize the importance of the three pillars of sustainability and how organizational elements and individualistic factors are intrinsically dependent on each other. As this world becomes more industrialized, technical

sustainability is increasingly vital as the processes of creating products and providing services should be sustainable. With a greater applicability to healthcare, individual sustainability such as healthy behaviours and self-management of chronic conditions may influence the demand for health services.

Contemporary analysts of sustainability often base their analyses using these assumptions. Learning from traditional ideas about sustainable development, people learned that the interrelationships between environmental, social, and economic dimensions comprise the core of sustainability and this has led to more recent analyses of sustainability (Canadian Medical Association, 2013; Prada et al., 2014; World Economic Forum, 2013) employing a systems perspective. Examining sustainability issues from a systems perspective moves decision makers away from the problem-solving method of analyzing resources, processes, outputs, and outcomes to looking at multidimensional relationships. If the goal in health system management is to have a sustainable health system, which is able to meet the dynamic population health needs and is financially feasible, applying performance measurement from a systems perspective entails considering influencing factors from all dimensions of sustainability.

2.1.2 Sustainability and the Health System

The three pillars of sustainability have served as a common ground for many sustainability standards and systems in the recent years. In the context of health system sustainability, Faezipour and Ferreira (2013) explain that the three pillars of sustainability need to be addressed to achieve overall health system sustainability. Health system sustainability contains factor categories such as patient, provider, resource, quality, finance, and community. They can be categorized under the three pillars of sustainability and are linked with each other. Faezipour and Ferreira (2013) study how patient satisfaction relates to the sustainability pillars.

Patient satisfaction is one of the key factors in the social pillar of health system sustainability. If patients are not satisfied with the services they receive as they flow through the health system, then the health services provided are not socially acceptable. When patients have a bad experience in the health system, they tend to affect other patients' attitudes toward the system. Negative opinions from patients about the health system will affect the working environment that the health system is in. The environment of the health system will further impact the economic operations of the health system (Faezipour and Ferreira, 2013). The study conducted by Faezipour and Ferreira (2013) on patient satisfaction and health system sustainability will be discussed later in this chapter.

The primary purpose of a health system is to promote, restore, and/or maintain the health of the population it serves (WHO, 2015). Due to the involvement of multiple stakeholders and processes, health systems are recognized as open and complex systems that are also influenced by economic and societal factors (Coiera & Hovenga, 2007). The complex nature of health systems often lead to different interpretations of the term, health system sustainability (Muzyka et al., 2012). For example, the Alliance for Natural Health International (2010) defines a sustainable health system as a “complex system of interacting approaches to the restoration, management, and optimization of human health ... that is environmentally, economically, and socially viable” (p. 9). This definition adopts Adams' (2006) three pillars of sustainability in health system management. The BC Innovation and Change Agenda (see Figure 5 on Page 6) referred to a sustainable publicly funded health care system for the BC health system to meet budget targets, be efficient, and obtain maximum value for money (Davidson, 2013). Therefore, merely the economic pillar of sustainability was emphasized. As the second strategic area mentioned in the newly-introduced BC Health System Strategy, sustainability is referred to as

the sustainable health service delivery system. This interpretation puts patients at the centre of the health system and considers other areas of health such as prevention and health promotion, quality diagnostic services, and primary and community care to meet dynamic patient needs (BC Ministry of Health, 2014b). Another integrated understanding of health system sustainability is the Conference Board of Canada's definition on health and health care sustainability (Prada et al., 2014), which will be discussed in detail later in this section. Despite different interpretations of health system sustainability, focusing either on the three pillars or in their interdependencies, the general consensus is that a long-term focus is needed to balance economic, social, and environmental factors when addressing health system sustainability (Fischer, 2015).

Steven Lewis (2007) believed that the Canadian health system was unsustainable not only from a financial perspective, but also a system-wide perspective. Lewis wrote that the Canadian health system was unsustainable because it was not adjusting to changes such as price increases of pharmaceutical drugs, the dynamic responsibilities of health providers, and the shifting health demands from acute illness to chronic conditions. This means that Canada is unable to sustain its health system operations at a desirable rate; hence, the effects became obvious: rising health expenditure, overcrowding of hospitals, and the decreasing access to health services. According to Lewis (2007), changes in the health system infrastructure are required to achieve sustainability. As well, there appears to be strong evidence indicating that the creation of health policies oriented towards lifestyle factors and the social determinants of health can contribute to health system sustainability. For example, the Canadian Medical Association (2013) has shown the importance of social determinants of health are for maintaining individuals' health (see Figure 11).

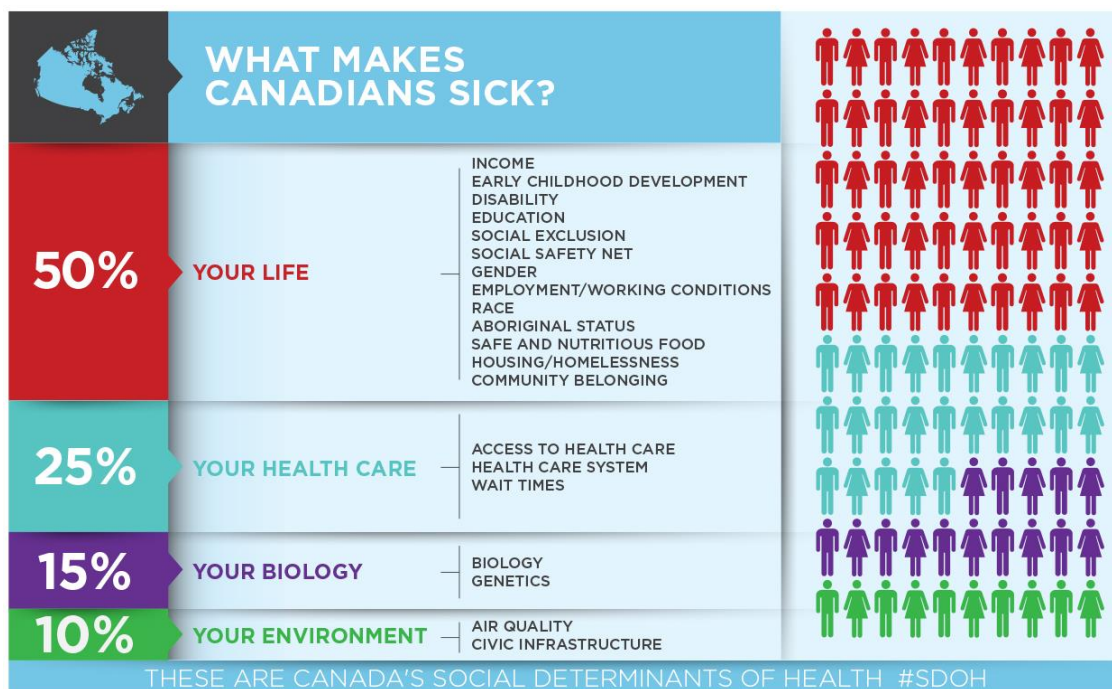


Figure 11: What makes Canadians sick? (Canadian Medical Association, 2013)

Social determinants of health influence people's lifestyles and the environment they live in. A sustainable health system is more attainable if government policy supports the creation and maintenance of health rather than treatment. To do this, health spending has to be shifted (in part) to alter lifestyle factors to reduce or even prevent sickness and illness (Astles, 2013).

The following section of this chapter reviews progress made globally to attain sustainable health systems.

Learning from the Top Performing Sustainable Health Systems

The Conference Board of Canada compared Canada's health system to those of 23 other OECD countries in 2004. Eighteen indicators were used to rank the 24 OECD countries in three categories: health status, non-medical factors, and health outcomes (see Table 2). The result of the analysis showed that Canada, as the third largest spender on health care in 2004, was ranked 13th among OECD countries on indicators related to health status, non-medical factors, and

health outcomes. This finding challenges health providers and policy makers to design and maintain sustainable health systems.

List of Ranked Indicators Used (by Category)		
Health Status	Non-Medical Factors	Health Outcomes
Life expectancy males / females	Body weight	Lung cancer mortality rates males / females
Disability-free life expectancy males / females	Tobacco consumption	Acute myocardial infarction mortality rates males / females
Self-reported health status	Alcohol consumption	Stroke mortality rates males / females
Infant mortality rate	Road traffic accidents	*PYLL suicide – (males)
Low birth weight	Sulphur oxide emissions	PYLL lung cancer males / females
	Immunization - DTP	PYLL breast cancer
	Immunization for influenza	
*Potential Years of Life Lost		

Table 2: The 18 Indicators to Rank OECD Countries (The Conference Board of Canada, 2004a)

In 2004, the Conference Board of Canada released a second report, *Challenging Health Care System Sustainability: Understanding Health System Performance of Leading Countries*, to examine five out of the top ten performing OECD countries identified in the previous report. The five countries are Switzerland, Sweden, Spain, France and Australia. The main question addressed is “why do their health care systems perform and produce better results than Canada’s health care system – and how do they do so?” (The Conference Board of Canada, 2004b, p. 5). The Conference Board of Canada grouped their findings based on three categories: structure, workforce, and other.

Structure

- Health outcomes: Spending more does not guarantee better health outcomes. As a top performer in health, Switzerland spends the most on its health system. Spain, however,

spends much less than Canada on health, but ranks third on health outcomes, and Canada ranks 20th.

- Privatization: Thirty percent of Canada's health spending comes from private sources. The percent of private spending on health in Canada is higher than Sweden, Spain, France, and Australia, which were all in the top ten performers.
- Pharmaceutical costs: Almost all OECD countries spend considerable amounts of health expenditures on pharmaceuticals. New Zealand, like few other countries that were successful with keeping drug costs down, did well with methods such as procurement strategies, supply-side controls (e.g., prescription size), and the use of price controls.
- Aging population: Sweden, Spain, and France have older populations than in Canada, but their health systems are not more expensive than in Canada.

Workforce:

- Information and communication technologies (ICTs) enhance patient care and may lead to greater productivity: In Canada, hospitals spent about 2.1 percent of their budgets on adapting and learning in new ICTs, while Sweden spent four percent on similar activities. Commitments to ICTs in health making electronic health records available to every health care provider may lead to better coordination of health services and higher quality of care.
- Continuing education engages health care providers: In Sweden, physicians are allocated up to 15 percent of their working time for continuing education and are encouraged to participate in research. Canada has no comparable figures and the Conference Board of Canada suggests that Canada under-invests in continuing education in health care.

Others:

- Determinants of health and non-medical factors: Countries with health systems that include determinants of health and non-medical factors (e.g., obesity and immunization) appear to measure better population health status and health outcomes (The Conference Board of Canada, 2004b).

The researchers found that there was no single factor that influences the balance between low-cost and high-quality health care.

The Sustainable Health Systems Project

The World Economic Forum launched the Sustainable Health Systems Project in 2012 to examine what health systems look like now, what they might look like in 2040, and how they could adapt to be sustainable. Workshops were conducted in China, Germany, the Netherlands, Spain, and England to identify national visions for sustainable health systems in 2040 and what strategies may be implemented by each country to achieve the outcomes. The main outcomes are investment in healthy living (China), maximize innovation (Germany), establish national health data standards (Netherlands), maximize quality of services (Spain), and shift health care from hospitals and into the community (England). The strategies that were identified to achieve these outcomes can be grouped into three areas: 1) use data and information to transform health and care, 2) develop healthy living environments, particularly in cities, and 3) promote disease prevention and patients managing their own health and illness (World Economic Forum, 2013).

Canadian provinces have been monitoring their health systems with a focus on short-term measures. These measures are mainly using data from acute care services such as wait times for emergency services and surgeries and the availability of hospital beds. While short-term

measures are important to monitor what and how health services are used, long-term measures should be used for planning and evaluation of health systems. Long-term measures such child poverty, population well-being, and levels of physical activity are important to achieve health system sustainability.

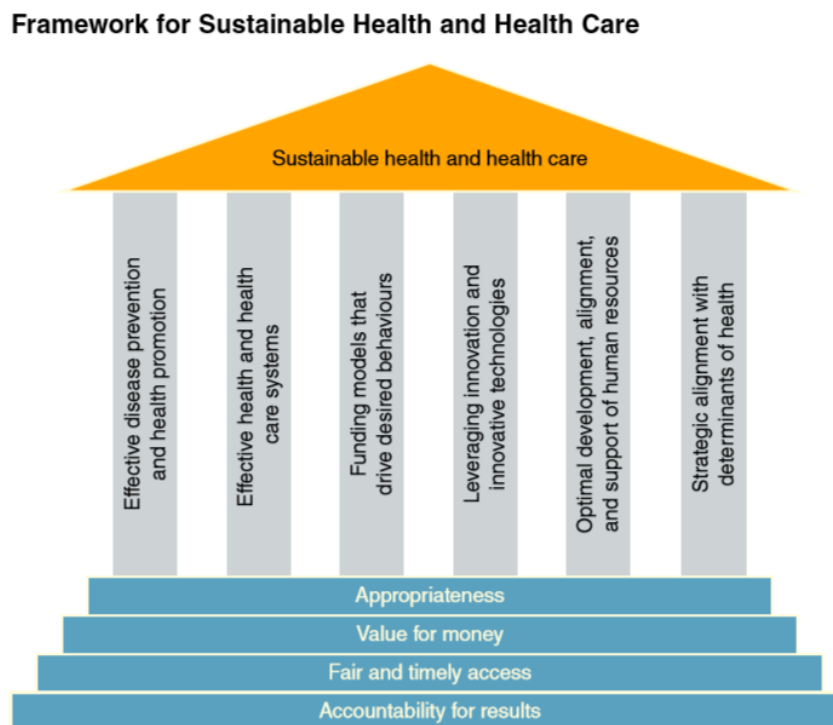
Health and Health Care Sustainability in Canada

In 2014, the Canadian Alliance for Sustainable Health Care (CASHC) program conducted a literature review and interviewed health care stakeholders across Canada to develop a definition of sustainable health for guiding health policy. The representatives include governments, health care organizations, for-profit and not-for-profit health insurance companies, life science organizations, and citizens and patients advocacy groups. The results from the interviews are included in the *Defining Health and Health Care Sustainability* report to define health and health care sustainability and illustrate a sustainability framework (Prada et al., 2014).

The Conference Board of Canada's CASHC program defines health and health care sustainability as "the appropriate balance between the cultural, social, and economic environments designed to meet the health and health care needs of individuals and the population (from health promotion and disease prevention to restoring health and supporting end of life) and that leads to optimal health and health care outcomes without compromising the outcomes and ability of future generations to meet their own health and health care needs" (Prada et al., 2014, p. 8). This definition develops upon the definition of sustainability in the Brundtland Report (Brundtland, 1987), and advocates a systems-based approach.

The sustainability framework consists of four guiding principles and six factors (see Figure 12). The four guiding principles are based on population's expectations of Canada's

health care system, and the six factors are defined as necessary to support sustainable health and health care. The framework is expanded from Adams' (2006) three pillars of sustainability.



Source: The Conference Board of Canada.

Figure 12: Health and Health Care Sustainability Framework (Prada et al., 2014)

Supporting health policy discussions and strategies implementation, the four guiding principles are:

1. **Accountability for results:** This principle calls for action in the three pillars of sustainability (economic, social, and environmental), and in other areas such as political and organizational contexts. Accountability should be in place in all levels of care.
2. **Fair and timely access:** Health services should be accessible to those in need is one of the main ideas held by the population. This principle is a high priority and it is critical to have political support so that adequate tax dollars can be used to sustain the publicly

funded health system.

3. Value for money: This principle ensures that better population health outcomes are achieved relative to the amount of investment in the health system. This principle includes the promotion of efficient and effective care, health system improvements, and the development of innovative technologies.
4. Appropriateness: This principle refers to ensuring that appropriate resources are spent at the appropriate time to provide necessary health services. It advocates resource optimization and Lean³ management (Prada et al., 2014).

Results from the 21 interviews with representatives from the health industry in Canada also identify six key factors for supporting sustainable health and health care:

1. Effective disease prevention and health promotion: All interviewees point out that a healthy population is a key factor to sustainable health systems. The rising prevalence of chronic conditions due to the aging population and poor lifestyle choices has increased the demand on the health system. Governments need to invest in and motivate more disease prevention and health promotion programs. More resources allocated in these programs may improve overall population health outcomes and can provide industries, corporations, and communities with financial opportunities by increasing employee productivity and satisfaction.
2. Effective health and health care systems: Evidence from the literature shows that around 40 percent of resources spent on health are wasted due to inefficiencies such as inappropriate hospital admissions, medical errors, and overuse or misuse of clinical

³ Lean is a systematic method for the elimination of waste within a manufacturing or production process. The core idea of Lean is to maximize customer value while minimizing waste.

interventions (WHO, 2010). Interviewees indicated that developing an effective health system may eliminate inefficiencies, maximize output, and improve health outcomes.

3. Funding models that drive desired behavioural changes: It was recognized during interviews that funding models, when implemented effectively, can help health organizations achieve health care targets and prevent inefficiencies. Studies on health systems in the United States point to financial incentives contributing to higher quality preventive care and chronic conditions management, and improved health outcomes (Øvretveit, 2009).
4. Leveraging innovation and innovative technologies: Interviewees agree that innovation and innovative technologies such as interoperable electronic medical records are essential for health system sustainability and can be a major proponent to health system transformation. When ICTs are effectively embedded in the health care processes, health systems can generate greater values than the expenditures for adopting these technologies.
5. Optimal development, alignment, and support of human resources: The sustainability of health systems may depend on the availability of health human resources (HHR), which include physicians, nurses, community health workers, social workers, and other health care providers. With the aging population, more health care professionals will likely exit the work force and the need for home and community care support may increase. HHR planning should recognize the shift in care needs and ensure adequate capacity in all care sectors for the increasing health care demand. An emphasis on developing skills to improve productivity of HHR may have a positive impact in health system sustainability.
6. Strategic alignment with determinants of health: There is a greater awareness that

focusing on determinants of health may improve population health outcomes. In the context of sustainable health and health care, the determinants of health may be more important than the access and utilization of health services because the determinants of health impact people's physical, mental, and social conditions, which in turn influences the utilization of health care. Arguably, governments should align health and social policies with determinants of health. More important, health expenditures should be controlled and regulated so that spending on other services such as education, housing, and environment will not be reduced (Prada et al., 2014).

After establishing and agreeing on the sustainability framework, the interviewees were asked to rank the ten framework elements, four principles and six factors, in the order of importance to sustainable health and health care. Table 3 shows the ranking of the elements that comprise the sustainability framework. Because of the inter-dependencies between the elements, the authors advocate a systems approach to achieving health system sustainability (Prada et al., 2014).

Ranking of Elements in Proposed Sustainability Framework

	Ranking
Effective disease prevention and health promotion	1
Accountability for results	1
Value for money	1
Effective health and health care systems	2
Leveraging innovation and innovative technologies	3
Funding models that drive desired behavioural change	4
Fair and timely access	5
Optimal development, alignment, and support of human resources	6
Strategic alignment with determinants of health	6
Appropriateness	7

Source: The Conference Board of Canada.

Table 3: Ranking of Elements in Proposed Sustainability Framework (Prada et al., 2014)

The report concludes that Canada currently does not have a national health care sustainability policy. Such a policy should address financial sustainability and other aspects of health system management. This policy may also be used to guide provincial governments to develop sustainable health systems (Prada et al., 2014).

Alberta's Triple Aim Initiative for Health System Sustainability

Alberta Health Services (AHS) has paid particular attention to the sustainability of its health system, with a focus on the economic pillar. AHS recognized the importance of moving from “a rescue system to a system which supports independence and early intervention for life-long health” (Horne, 2013, p. 2). The Health Minister in Alberta, Fred Horne, identified the three main drivers for change in the AHS: 1) overused hospital-based health system, 2) an unsustainable spending curve, and 3) increasing health needs from patients with chronic conditions. Horne also points out that to make Alberta's health system sustainable new approaches are required around access, quality, and the cost of health care (Horne, 2013).

The AHS adopted the Triple Aim Initiative from the Institute for Healthcare Improvement (IHI) in 2013. The initiative (see Figure 13) was implemented as a health care quality improvement approach to address three strategic directions and four goals:

Strategic direction – Bringing appropriate care to community.

Goal 1: build a strong integrated community and primary health care foundation to deliver appropriate, accessible, and seamless care.

Strategic direction – Partnering for better health outcomes.

Goal 2: actively engage Albertans as partners and provide them with the support they need to take responsibility for their health and that of their families.

Goal 3: advance the adoption of evidence-informed practices in the delivery of quality services across the continuum through partnership with providers, academic institutions, physicians and others.

Strategic direction – Achieving health system sustainability.

Goal 4: continue to build a sustainable, quality health system that is patient centred, driven by outcomes and informed by evidence (AHS, 2014b).

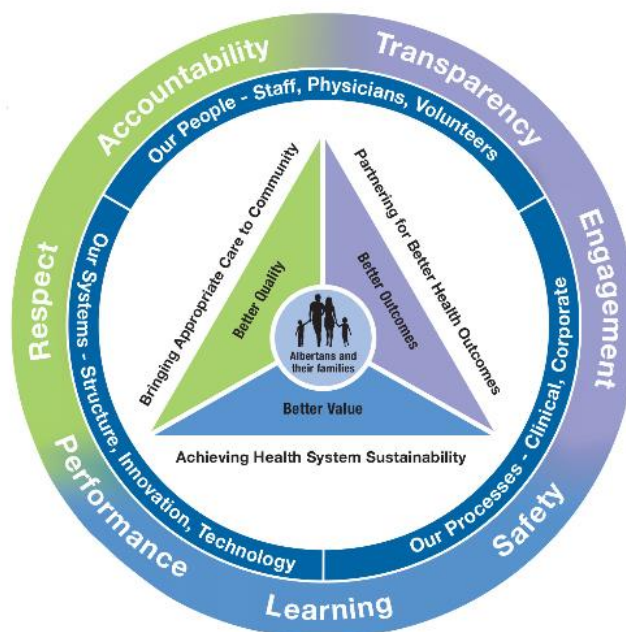


Figure 13: AHS Uses Triple Aim to Guide Strategic Directions (AHS, 2014b)

The goal of the Triple Aim Initiative in Alberta is to apply change management to improve care and outcomes and achieve better value from 2013 to 2016. Horne explained that only when health outcome, patient experience, and health expenditure are improved, can the health system be sustainable. Horne defined sustainability as the “perseverance through adaptation and change” (Horne, 2013, p. 6) and suggests that sustaining the operation of health system is an ongoing process of learning, measuring, and improving.

In Alberta, the Triple Aim Initiative is also applied to encourage people to use primary health services more than hospital care services. Accessibility of primary care is the focal point in health quality improvements. Primary care networks and family care clinics in communities were established across the province to shift the population's utilization of the more expensive acute care system. When the health demand is appropriately addressed in the primary care

system and money is saved from the acute care system, then funding can be allocated elsewhere to improve health outcomes and patient experience of care.

Health System Sustainability in British Columbia

BC Ministry of Health emphasizes sustainability in its health service delivery system. The Ministry's newly-published Health System Strategy aims to answer this question: what kind of sustainable health service delivery system does BC need to meet population health outcomes, with what level of quality? (BC Ministry of Health, 2014b). In response to this question, the Strategy outlines eight priority areas such as providing patient-centred care, examining acute care system roles and functioning, and increasing access to appropriate residential care services⁴.

The following statistics indicate that BC faces health demands and health system sustainability issues similar to Alberta: increasing population, increasing seniors population, and the increasing prevalence of concurrent and complex chronic conditions:

- By 2036, 25 percent of the BC population will be over age 65 (up from 16% in 2013) and 8 percent of the population will be over age 80 (up from 4.5% in 2013) (BC Stats, 2013).
- The 80+ population is expected to grow four times faster than the BC total population (BCMA, 2012, p. 2).
- The median age in the province will increase from 41.7 in 2013 to 45.5 to 2036 (BC Stats, 2013).
- The proportion of the labour force⁵ will drop from 66 percent in 2013 to 59 percent in 2036 (BCMA, 2012, p. 2), which means fewer workers paying the highest taxes to

⁴ See [Appendix A](#) for all eight priorities.

⁵ The labour force consists of people age between 18 and 64.

support the health system.

The growth in the senior population may increase the use of hospital services and increase the demand for other government funded services relating to residential care, and home health support.

While the proportion of the BC population age 65 and older is increasing, the number of people with chronic conditions is also increasing:

- By 2036, it is estimated that one million new patients will be diagnosed with the top five chronic conditions (depression, hypertension, osteoarthritis, diabetes and asthma) in BC (BCMA, 2012, p. 6).
- In 1985, 11 percent of BC's population were overweight. In 2011, 45 percent were overweight (BC Ministry of Health, 2011).
- Obese Canadians are 4 times more likely to have diabetes, 3.3 times more likely to have high blood pressure, and 56 percent more likely to have heart disease than those with healthy weights (BC Ministry of Health, 2011).
- In 2006, substance use⁶ was estimated to cost BC \$6 billion in direct and indirect costs. Of this 22 percent, or \$1.32 billion, were in health costs (Rehm et al., 2006, p. 4).

Many chronic conditions are caused by obesity and inactivity. Approximately 46 percent of BC residents are not active enough to achieve the health benefits of regular activity (ActNowBC, 2006, p. 21).

Health care is the largest public expenditure in BC. The following statistics (below) highlight the increasing health expenditures:

⁶ Substance use is used to be known as “addictions” or “substance abuse.”

- Health operating expenditure in BC grew from \$8.7 billion in FY 2000/2001 to \$15.9 billion in FY 2012/2013 (BC Ministry of Health, 2013a).
- In 2008, the average per capita cost for people over age 80 was \$15,137, which was five times the average cost of \$3,333 per person in health spending (BCMA, 2012, p. 4).
- In FY 2011/2012, health authorities spent \$7.4 billion in acute care, which was 58.7 percent of the total health authorities' expenditure (\$12.6 billion). Only \$2.6 billion, or 20.6%, was spent in community care (Office of the Auditor General of BC, 2013).
- Those over age 60 account for half of total health expenditures (BCMA, 2012, p. 5).

Health system sustainability is a focal point for many governments and health organizations around the world. This section of the chapter provided a review of historic development of sustainability concepts, definitions, and frameworks. Global endeavours to develop and maintain sustainable health and health care have been documented and discussed. Table 4 summarizes the key sustainability framework elements and their inclusions in the three sustainability frameworks described in this section.

Sustainability Framework Elements	World Economic Forum	The Conference Board of Canada	Alberta Health Services
Effective disease prevention and health promotion	•	•	•
Accountability for results		•	
Value for money		•	
Effective health and health care systems		•	
Leveraging innovation and innovative technologies	•	•	•
Funding models that drive desired behavioural change		•	
Fair and timely access		•	•
Optimal development, alignment, and support of human resources		•	•
Strategic alignment with determinants of health	•	•	
Appropriateness		•	•

Table 4: Sustainability Framework Elements Comparison

This section has also highlighted interrelationships and the need for sustainability to be drawn from a systems-based model. Managing specific areas in health care has been proven

ineffective and wasteful. Developing from the knowledge gained about sustainability and its application to health systems, the following section will discuss the purpose of conducting system performance measurement and review Canadian national and provincial examples of performance measurement frameworks.

2.2 System Performance Measurement

2.2.1 Performance Measurement

Performance measurement is the process of monitoring, evaluating, and communicating the performance of an individual, organization, or system against their key objectives (Smith et al., 2010). This research focuses only on the measurement process of a health system.

Background

Historically, performance measurement practices are developed and applied to monitor and maintain organizational control, which guides an organization's strategies to achieve its overall goals and objectives (Purbey et al., 2006). Through identifying a system's strengths and weaknesses, performance measurement can provide an understanding of how well systems are progressing towards their objectives. Performance measurement explains what happened, but not why it happened. Results from performance measurement and assessment inform the management team on areas of improvement for the system and sometimes are able to answer the why questions.

It is recognized that traditional performance measurement practices emphasize too much of the financial dimension (Neely et al., 2000). In contrast, a systemic approach includes other performance dimensions and measures to assess system performance. The development of performance measurement practices identifies a performance management cycle consisting of

four major stages: plan, design, measure, and analyse (Santos et al., 2002). Performance measurement is embedded in this cycle as one of the four stages (see Figure 14).

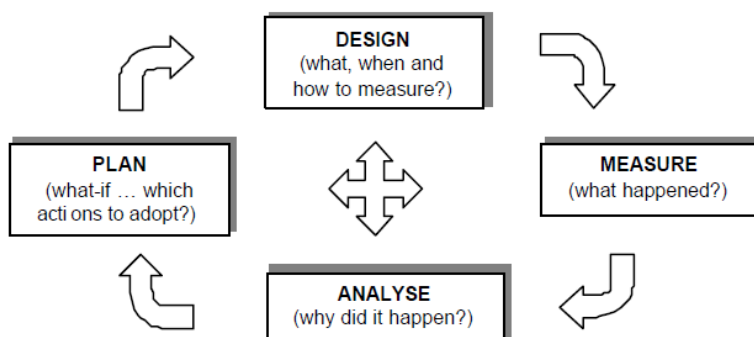


Figure 14: The Performance Management Process Life Cycle (Santos et al., 2002)

If the goal of performance measurement is to influence continuous performance improvement, the four stages should not be considered in a linear and sequential way. The crossed arrows in the middle illustrate that the performance management cycle is multidimensional, dynamic, and iterative.

Purpose

The choice of performance measurement depends on the purpose of the measurement. For example, performance measurement has been used in decision making, resource allocation, budget planning, employee motivation, contract monitoring, accountability holding, and service and communications improvement between governments and citizens (Wholey and Hatry, 1992). Generally speaking, performance measurement can be applied in public sectors for eight managerial purposes (Behn, 2003): 1) to evaluate: how well the system is performing; 2) to control: how managers ensure the system is doing the right thing; 3) to budget: on what programs or people government should spend taxpayers' dollars; 4) to motivate: what the right incentives are to improve performance; 5) to promote: how to validate success and encourage good areas of performance; 6) to celebrate: what accomplishments are worthy of celebrating; 7) to learn: what

is and is not working, and why; and 8) to improve: what exactly should who do differently to improve performance. According to Behn (2003), all functions of performance measurement can be categorized under these eight purposes. Behn also stated that without proper intellectual and operational capacity to learn from analysis of performance measurement, nothing could be accomplished.

Performance Measurement Framework

An effective performance measurement framework should be sensitive to changes in internal and external environments of an organization (Purbey et al., 2006). According to Neely et al. (2003), all published performance measurement frameworks can be categorized into two generations: first and second performance measurement systems generations. The first generation systems supplemented the traditional financial measures with non-financial and often intangible measures. The first generation systems provided a broader perspective on organizational performance and further identified the importance of linking and integrating performance measures. Below are samples of three frameworks in the first generation:

1. Keegan et al. (1989) introduced the *Performance Measurement Matrix* (see Figure 15), which includes both financial and non-financial measures. However, the *Performance Measurement Matrix* is often criticized for putting too much emphasis on lag measures, but not enough attention was paid at lead measures. Lag measures tell the story of past performance, while lead measures focus on predictive and forward-looking performance comparisons.

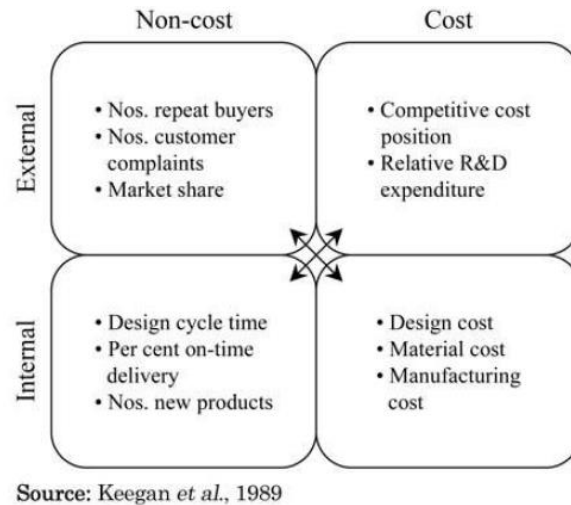


Figure 15: Performance Measurement Matrix (Neely et al., 2000)

2. Kaplan and Norton (1996) presented the *Balanced Scorecard Framework* (see Figure 16) for system performance measurement. The Balanced Scorecard approach divides organizational performance into four important perspectives: financial, customer, internal business, and learning and growth. The strengths of this framework include its multidimensional view of system performance (Atkinson and Brown, 2001); its linkage between business performance to organizational strategy (Neely, 2002); and its ability to communicate feedback on corporate strategies (Anthony and Govindorajan, 1998). The drawbacks of the system are the lack of consideration to the measurement of human resource, supplier performance, and system environmental factors (Lingle and Schiemann, 1996); the absence of measuring the competitiveness dimension of system performance (Fitzgerald et al., 1991; Neely et al., 1995); and the inability to integrate high-level strategies and operational-level measures (Hudson et al., 2001). The Balance Scorecard includes lead performance measures in areas such as learning, innovation, and customers.

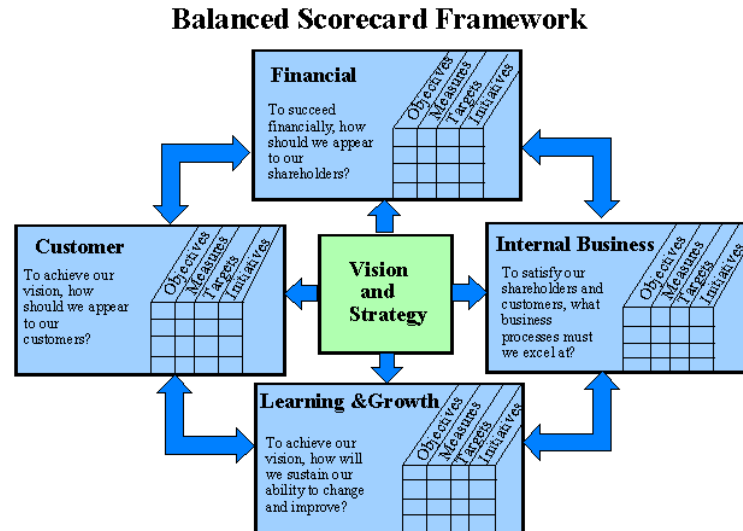
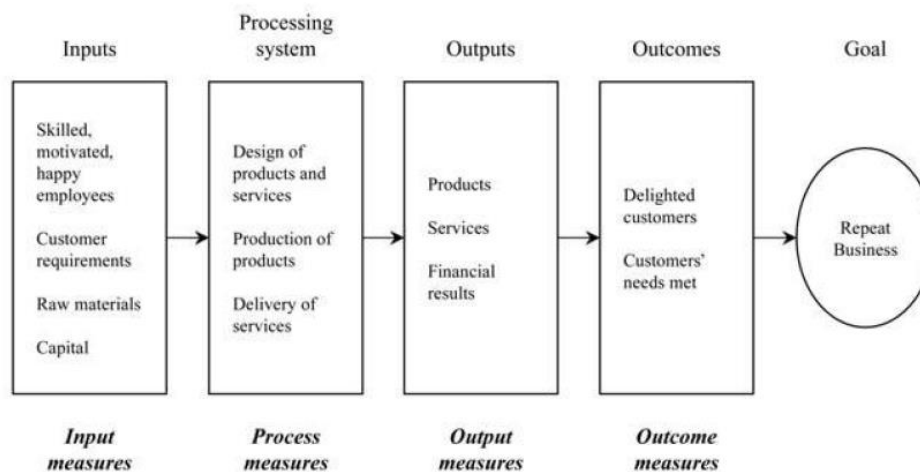


Figure 16: Balanced Scorecard (Neely et al., 2000)

3. Brown's (1996) *Input, Processes, Outputs and Outcomes Framework* (see Figure 17) is theoretically appealing and spotlights the different measures used in various stages of performance measurement. This framework introduces the concept of linking performance measures through unidirectional cause and effect relationships. Within Brown's framework, lead performance measures can be applied in input and processes dimensions to create better results in outputs and outcomes dimensions (Purbey et al., 2006).



Source: Brown, 1996

Figure 17: Inputs, Process, Outputs and Outcomes Framework (Neely et al., 2000)

Other examples of first performance measurement systems include the *Performance Measures for Time-based Competition Framework* (Azzone et al., 1991), the *Performance Pyramid System* (Judson, 1990; Lynch and Cross, 1991), and the *Performance Prism* (Neely, 2002).

Neely et al. (2003) argued that the first generation performance measurement systems, such as the Balanced Scorecard and the Performance Prism, can only identify the need for the inclusion of non-financial indicators to a better comprehensive measurement of performance. The second generation performance measurement systems provide a significant improvement in measurement due to their abilities to realize the dynamics of value creation, link system variables together across performance dimensions, and visualize the linkage between financial assets and business value with a conceptual framework, map, or model (Neely et al., 2003). Examples of second generation performance measurement frameworks include the *Intellectual Capital Navigator Model* (Roos and Roos, 1997), the *Strategy Map* (Kaplan and Norton, 2000), and the *Value Creation Map* (Marr et al., 2004; Neely et al., 2002). Below are descriptions for these three systems:

1. *Intellectual Capital Navigator Model*: As management theories pointed out that “hidden assets” such as employee knowledge, customer relations, and brand loyalty have become increasingly important to corporate survivability, companies started to pay more attention to intellectual capitals (Roos and Roos, 1997). The *Intellectual Capital Navigator Model* was introduced to measure and predict companies’ intellectual performance, which is the fluctuation of intellectual capitals of the company and can display an early warning signal of subsequent financial performance. The model (see Figure 18) is a distinction-tree like, conceptual framework for companies to understand and seek sustainable competitive

advantages from both internal and external environments of the company. The model contains three main intellectual categories: human capital, organizational capital, and customer and relationship capital. Each category includes further sub-categories with the organizational capital having both business process capital and business renewal and development capital. Depending on the company strategy, different categories are considered more important than others in their evaluation. The *Intellectual Capital Navigator Model* was a success because it identified the “hidden assets” of companies and included them for performance measurement. Once relevant intellectual capital categories are recognized, data can be collected for chosen indicators to capture, measure, and manage the intellectual performance in companies (Roos and Roos, 1997).

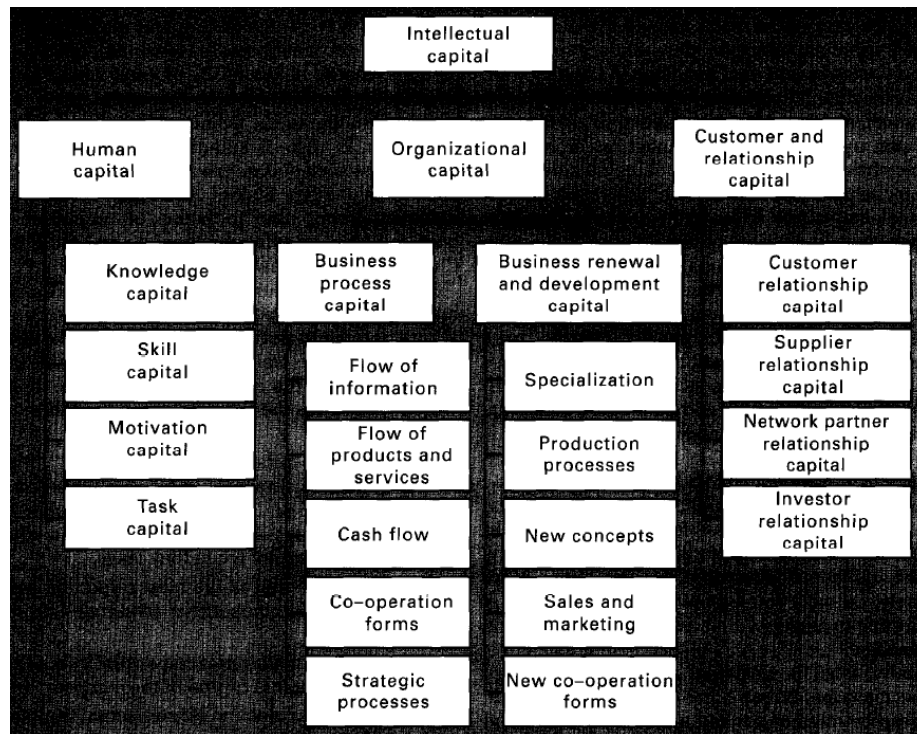


Figure 18: Intellectual Capital Navigator Model (Roos and Roos, 1997)

2. *Strategy Map*: Kaplan and Norton (2000) introduced a tool for creating a strategy-driven performance management organization called strategy mapping (see Figure 19). This

mapping process illustrates how values are created by connecting strategic objectives in explicit cause-and-effect relationships between objectives from the four Balanced Scorecard perspectives.

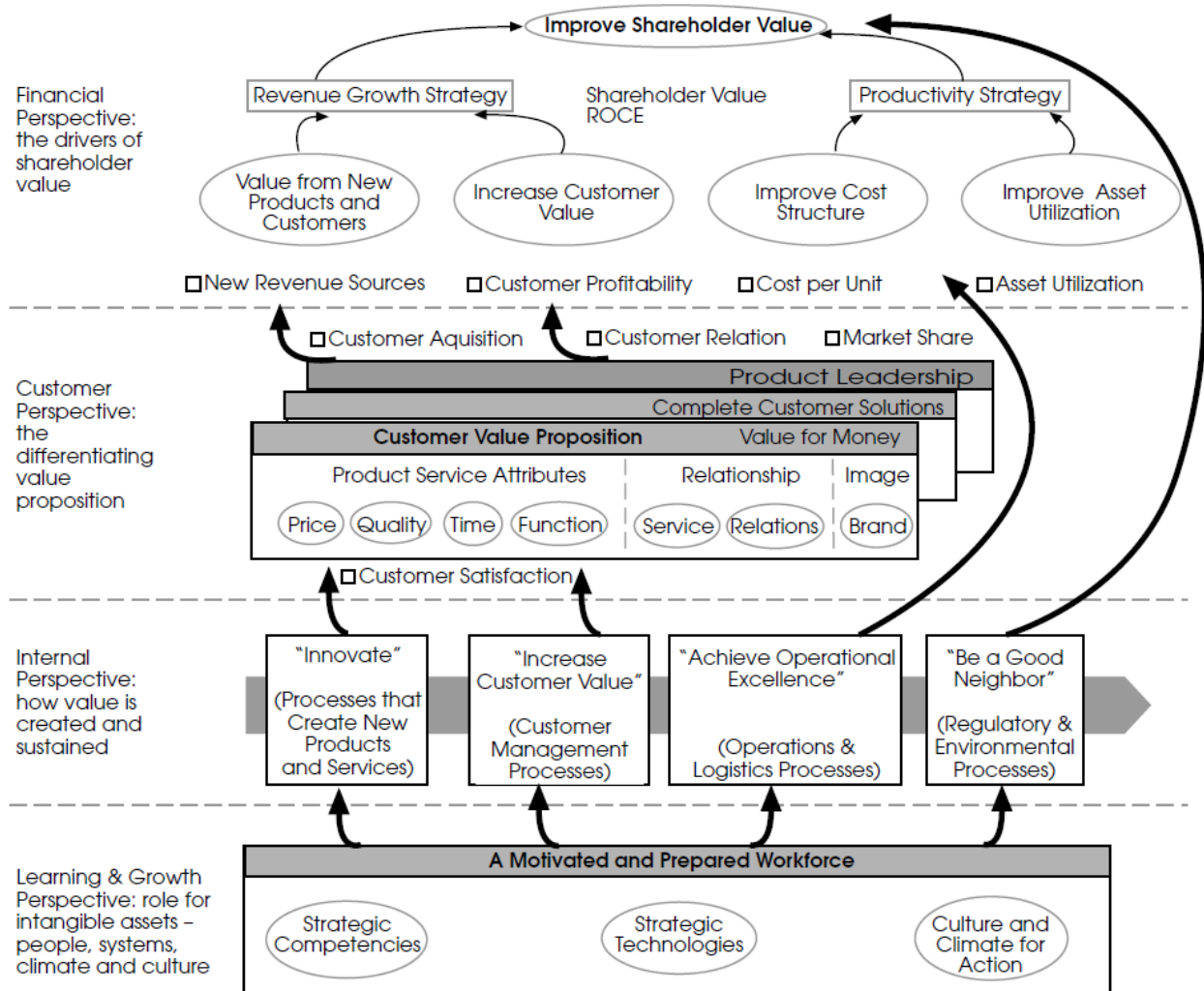


Figure 19: Strategy Map (Kaplan and Norton, 2000)

Presenting the connections between objectives such as shareholder value creation, customer management, process management, core capabilities, innovation, information technology, and learning and development on one map helps to communicate the implementation strategy to executives and deliver enabling strategies to employees

(Kaplan and Norton, 2000). The successful implementation of strategy maps is based on the following five principles for achieving strategic focus and alignment:

- a. Principle One: translate strategy into operational terms.
- b. Principle Two: align the organization to the strategy.
- c. Principle Three: make strategy everyone's everyday job.
- d. Principle Four: make strategy a continual process.
- e. Principle Five: mobilize change through executive leadership.

Strategy maps provide visual frameworks for integrating organizational objectives, illustrate causal relationships by linking human, information, and organization capitals with process excellence, and align process excellence with desired outcomes in customer and financial perspectives (Kaplan and Norton, 2000).

3. *Value Creation Map*: Value creation maps highlight how linking intangible resources and organizational assets can create value (Marr et al., 2004; Neely et al., 2002). Although the *Strategy Map* is an enhanced version of the *Balanced Scorecard*, critics often point out that by only identifying cause-and-effect relationships in the four Scorecard perspectives, the *Strategy Map* is not taking into account the interconnectivities of objectives in the four perspectives. The value creation mapping process is designed to enhance the strategy mapping approach because it expands the linear and one-dimensional causal relationship to nonlinear and dynamic interrelationships of system variables and organizational assets (Neely et al., 2002). Marr et al. (2004) provided a taxonomy of organizational assets, which are classified as financial assets, physical assets, relationship assets, human assets, culture assets, practices and routine assets, and intellectual property assets. It is through value creation maps that a better understanding

of success factors can be achieved to convert intangible assets into tangible outcomes and support decision making.

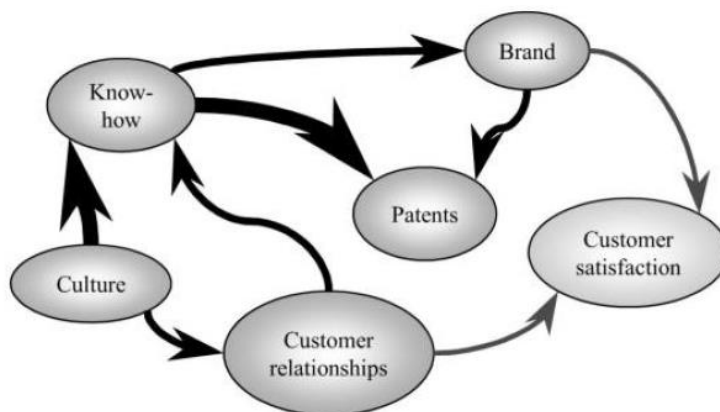


Figure 20: A Simplified Value Creation Map for Improving Customer Satisfaction (Marr et al., 2004)

Value creation maps are developed from data extracted from the matrix of direct and indirect dependencies (Neely et al., 2002). The matrix of direct dependencies is a table with organizational assets listed in the rows and performance dimensions such as strategic objectives listed in the columns. A weighing scale of importance is included in the table to show relative criticality of each organizational asset for the achievement of each performance dimension. This matrix of direct dependencies can help executives identify an organization's key value drivers. The matrix of indirect dependencies has a similar table, but with key value drivers in both rows and columns. Value creation points can be described through examining interactions amongst key value drivers. A matrix of indirect dependencies can be generated for each performance objective. Figure 20 shows a simplified sample *Value Creation Map* for an organization to improve customer satisfaction by strengthening customer relationships and raising brand reputation using key value drivers identified by the matrix of direct and indirect dependencies (Marr et al., 2004).

This section describes background, purposes, and frameworks of performance measurement, with a focus on performance measurement for systems. Reviewing the historic development of organizational performance measurement exhibits the progress made to date. From focusing only on financial and tangible indicators to including non-financial and intangible indicators, the modern performance measurement systems have a wider coverage on organizational performance demonstrating a shift from measuring based on objectivity to subjectivity. As the levels of complexity in health systems are acknowledged, a similar shift in measuring health system performance is desired. The sole reliance on using tangible data from administrative, clinical, and medical databases to evaluate health system performance can no longer suffice. The ongoing development and improvement of performance measurement systems in healthcare need to follow the lessons from the second generation performance measurement systems: link system variables across performance dimensions; establish linkages between financial assets and business values; and embrace the dynamics of value creation.

The next section examines Canadian examples of health system performance measurement systems. In particular, a national sample from CIHI and a provincial sample from the Alberta Health Services will be described and studied.

2.2.2 Health System Performance Measurement – Canadian Frameworks

Canadian National Health System Performance Measurement Framework

CIHI's new Health System Performance Measurement Framework offers jurisdictions a common approach for measuring health system performance from a pan-Canadian perspective. The goal of this framework is to understand how to measure and improve health system performance in Canada. It builds on the success of CIHI-Statistics Canada Health Indicator

Framework (see Figure 21), which was published in 1999. See [Appendix B](#) for the detail version of the Health Indicator Framework with performance dimension definitions.

Health Indicator Framework

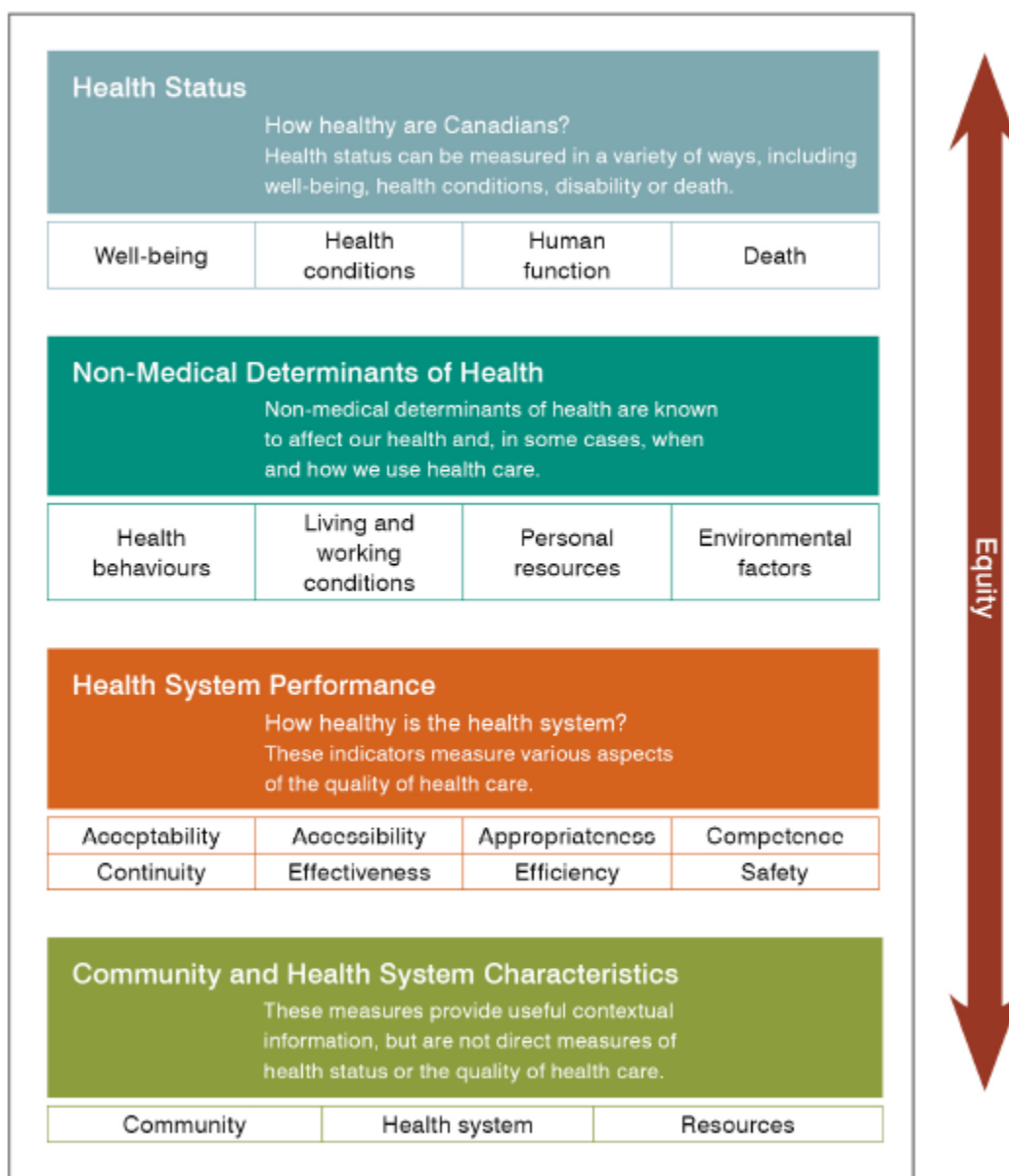


Figure 21: The CIHI-Statistics Canada Health Indicator Framework (CIHI, 2013a)

The CIHI-Statistics Canada Health Indicator Framework was well-accepted nationally and was globally recognized and endorsed as a technical standard by the International Standardization Organization in 2010. The CIHI-Statistics Canada framework also has shortcomings. It was not designed to explain the expected relationships between various dimensions of health system performance. The publication of Kaplan and Norton's Balanced Scorecard in 1996 started the movement to have performance measurement aligned with specific objectives set by organizations or systems (Kaplan & Norton, 1996). It was important to update the older CIHI framework to reflect scientific developments in understanding performance measurement and improvement that had occurred since 1999 as well as including the recent emphasis from provincial governments on performance domains such as sustainability (value for money), safety (patient safety), and acceptability (patient-centredness). Therefore, an updated framework was needed for several reasons: consideration of the evolving performance information needs, application of the current state of scientific knowledge, and accentuation of performance dimensions for managing and improving health system performance (CIHI, 2013b).

The Framework

CIHI's Health System Performance Measurement Framework was developed between June 2012 and July 2013 through cross-country consultations with provincial ministries, key stakeholder organizations, advisory groups, and the public (CIHI, 2013a). The framework consists of four interrelated quadrants: Health System Inputs and Characteristics, Health System Outputs, Health System Outcomes, and Social Determinants of Health (see Figure 22).

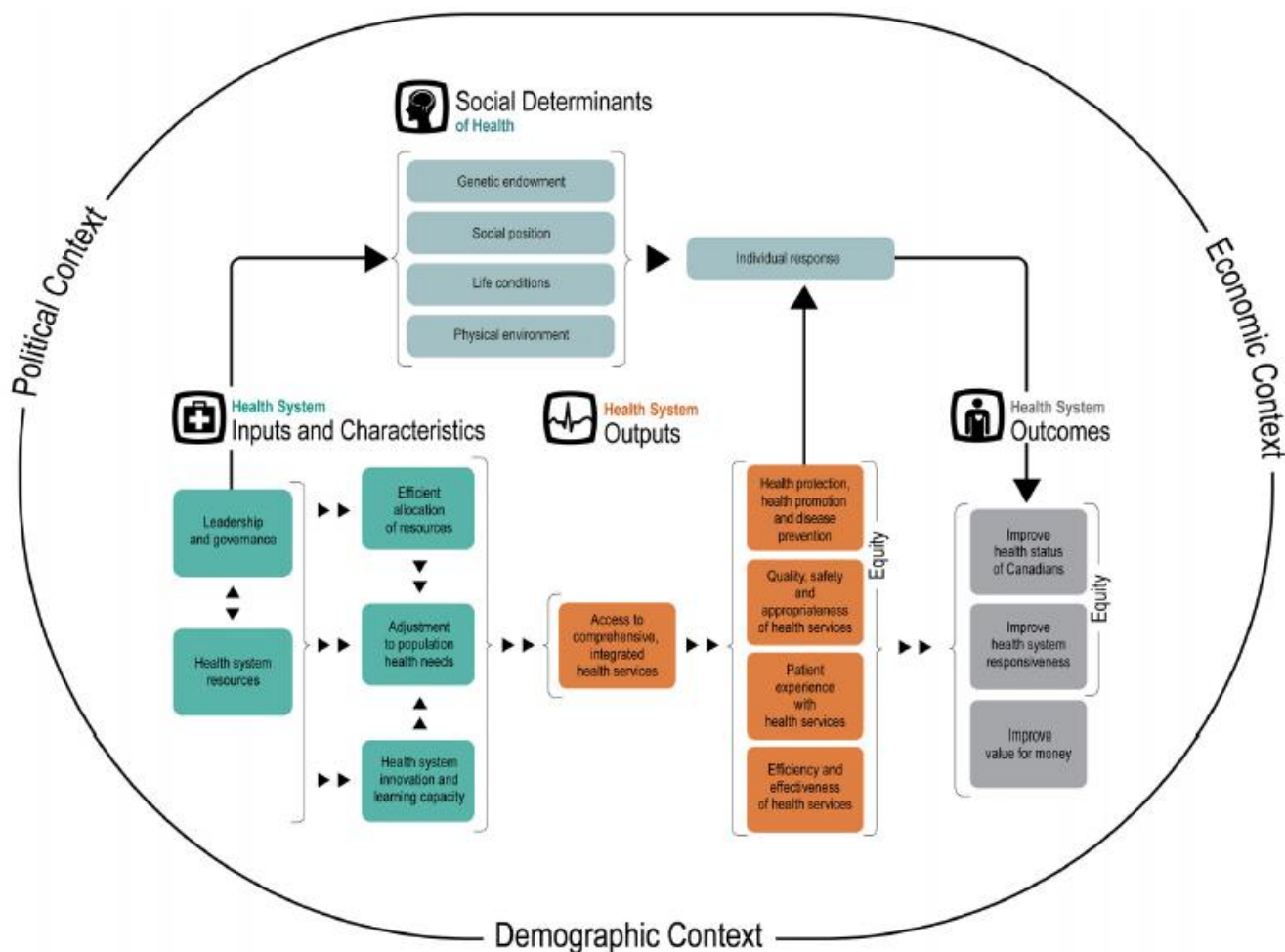


Figure 22: CIHI's Health System Performance Measurement Framework (CIHI, 2013b)

These four quadrants are viewed within political, economic, and demographic contexts. Each quadrant contains performance dimensions linked through expected causal relationships, which are influenced by the contextual environments in which the quadrants reside. The quadrants are:

1. Health System Inputs and Characteristics – This quadrant represents the internal components of the health system. The internal components are considered as prerequisites of health system performance, they influence performance directly, and are viewed as levers of health system performance improvement. As shown in the framework, the internal components are leadership and governance, efficient allocation of

health system resources, adjustment to population health needs, and health system innovation and learning capacity.

2. Health System Outputs – This quadrant contains dimensions relating to characteristics of the health services produced by the health system. It can be divided into two components. The first component represents the capacity of the system to deliver high-quality services such as health promotion and disease prevention to the population in an equitable way. The second component reflects the quality attributions of health services: person-centred, safe, appropriate and effective, and efficiently delivered. As shown in the framework, there is a causal relationship between the two components. The accessibility of comprehensive and integrated health services leads to the success of several characteristics of health services, especially patient-centeredness, safety, and effectiveness of care. The two components of this quadrant contain five dimensions of performance: 1) access; 2) health protection, promotion, and disease prevention; 3) quality, safety, and appropriateness of health services; 4) patient experience; and 5) efficiency. The outputs discussed in this quadrant include all outputs from the provision of health services via different health sectors: primary, acute, community, promotion, and prevention. The attainment of outputs from these care sectors impacts the success of health system outcomes, which is the next quadrant.
3. Health System Outcomes – This quadrant corresponds to three inherent goals of the Canadian health system: improve health status of Canadians, improve health system responsiveness, and improve value for money. They are discussed below:
 - a. The goal of improving health status of Canadians is subdivided into the following three elements:

- i. Health conditions, which are health problems and changes of health status such as diseases and injuries. These conditions can be measured in the population by prevalence rate, incidence rates, or condition-specific mortality rates.
 - ii. Human functioning, which is the general health status and functioning capacity of the population associated with the consequences of illness. It can be measured by potential years of life lost or healthy life expectancy.
 - iii. Well-being, which is the level of physical, mental and social well-being of individuals. It can be measured by examining material conditions, quality of life, and sustainability of well-being over time.
- b. Improving health system responsiveness means the health system must provide services to improve population health in a way that satisfies the needs and expectations of the people it serves. This goal also implies an equitable distribution of health status and system responsiveness across different socio-economic cohorts.
 - c. Improving value for money indicates the level of achievement of health system outcomes in relation to the resources used. The term “value” in the framework pinpoints the ability of the health system to balance the allocation of resources to obtain the best health outcomes such as health status, health system responsiveness, and equity for the resources used.

These three goals are also referred to as the three performance dimensions under the health system outcomes quadrant. The dimension of equity is applied to the first two dimensions.

4. Social Determinants of Health – This quadrant includes the factors that are outside of the health system and influence a population’s health behaviour. As shown in the framework, individual responses to health system outputs are impacted by structural factors of social determinants of health, which are social position, life condition, physical environment, and genetic endowment. These factors shape individuals’ and families’ socioeconomic position such as income and social status, education, gender, and ethnicity. Structural factors can also impact biological, material, psychosocial, and behavioural factors, which are collectively referred to as “intermediary determinants of health.” Sub-factors of the intermediary determinants of health include:
- a. Biological: genetic endowment, aging processes, and sex-related biology.
 - b. Material: characteristics of neighbourhoods, homes, workplaces, and the physical environment.
 - c. Psychosocial: stress, sense of self-control, social support networks.
 - d. Behavioural: physical exercise, diet, substance use, and nutrition.

These intermediary determinants of health can influence an individual’s health positively and negatively. Measuring the intermediary determinants of health is essential to understand what shapes population health and health inequality. While it is imperative to recognize that social determinants of health play an important role in population and public health, having an efficient health system could allow resources to be reallocated to other governmental sectors such as education (e.g. prenatal education and early childhood education to prevent low birth weights and child obesity) and social services (e.g. home health care, rehabilitation, and community support).

International Frameworks Comparison

The CIHI Health System Performance Measurement Framework has an extensive coverage on performance dimensions compared to international performance frameworks. Seventeen commonly used performance dimensions are identified by CIHI-conducted studies on international health performance measurement frameworks. Table 5 lists these 17 performance dimensions and compares them to performance dimensions among the Commonwealth Fund (2007), the World Health Organization (WHO) (Murray & Frenk, 2000), OECD (Hurst & Jee-Hughes, 2001; Kelley & Hurst, 2006), the Institute for Healthcare Improvement (Stiefel & Nolan, 2012), and CIHI (2013a). Reviewing performance dimensions used in other jurisdictions and by other organizations will help this research to identify performance dimensions to measure health system sustainability in BC.

	Commonwealth Fund ⁶¹	WHO ²	OECD ⁶²	OECD ⁶⁰	IHI ⁶³	CIHI
Accessibility	•		•			•
Comprehensiveness						
Continuity of Care						•
Integration						
Appropriateness of Care	•					•
Effectiveness	•			•		•
Safety	•			•		•
Competence or Capability	•					•
Patient Experience	•	•*	•*	•	•	•
Productivity or Technical Efficiency						•
Expenditure or Cost		•	•		•	•
Responsiveness/Trust in the Health System		•*	•*	•		•
Efficiency	•		•			•
Healthy Lives or Health Status Improvement	•	•	•		•	•
Equity	•	•	•			•
Efficient Allocation of Resources						•
Innovation and Capacity to Improve	•					•

Table 5: A Comparison of CIHI and International Performance Domains (CIHI, 2013b)

Based on the ratings of the US health system in its national Scorecard (see Figure 23), the Commonwealth Fund Commission proposed to cover 10 out of the 17 performance dimensions outlined in the above table. The proposed agenda advised the President and Congress to focus on five key strategies for change: affordable coverage for all, aligned incentives and effective cost control, care coordination, quality and efficiency, and accountable leadership (The Commonwealth Fund Commission, 2007).

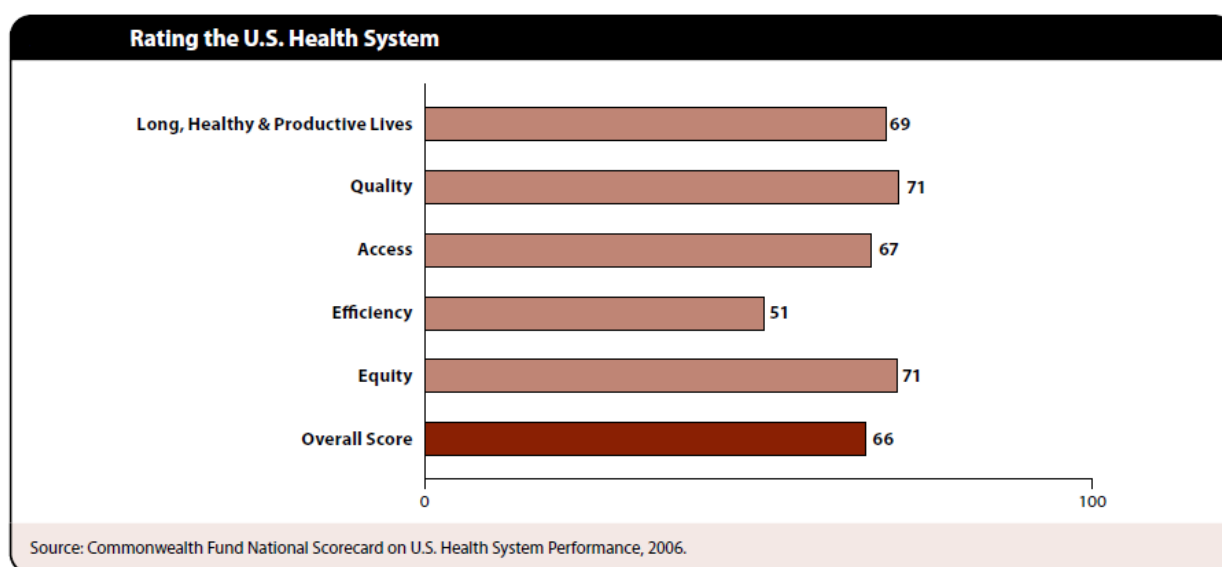


Figure 23: The Six Performance Domains in the US National Scorecard (The Commonwealth Fund Commission, 2007)

The World Health Organization identified three areas of goals for the health system (see Figure 24): defining goals of the health system, common goals of all social systems, and health system goals affecting other social systems. The three areas of goals covered five performance dimensions: patient experience, health expenditure, responsiveness of the health system, health status improvement, and equity. The goals and performance dimensions were incorporated to establish a performance management framework for assessing the performance of health systems (Murray & Frenk, 2000).

Social goals	Social systems				
	Education	Health	Economic	Political	Other
Education	Defining goal of each system	Other goals affected	Other goals affected	Other goals affected	Other goals affected
Health	Other goals affected	Defining goal of each system	Other goals affected	Other goals affected	Other goals affected
Consumption	Other goals affected	Other goals affected	Defining goal of each system	Other goals affected	Other goals affected
Participation	Other goals affected	Other goals affected	Other goals affected	Defining goal of each system	Other goals affected
Other	Other goals affected	Other goals affected	Other goals affected	Other goals affected	Defining goal of each system
Responsiveness to expectations	Goals common to all systems	Goals common to all systems	Goals common to all systems	Goals common to all systems	Goals common to all systems
Fairness in financial contribution	Goals common to all systems	Goals common to all systems	Goals common to all systems	Goals common to all systems	Goals common to all systems

■ Defining goal of each system
■ Goals common to all systems
■ Other goals affected

Figure 24: WHO's Social Systems and Associated Goals (Murray & Frenk, 2000)

The OECD health systems grouped their health indicators into four main categories: health outcome, responsiveness, equity, and efficiency (Hurst & Jee-Hughes, 2001). The four main categories are used as horizontal and vertical dimensions in the OECD Health System Performance Framework (see Figure 25). The health system performance framework for OECD health systems adapted Murray's and Frenk's (2000) work in the framework from WHO. The three overall goals from WHO framework were taken into consideration and altered to: health improvement/outcomes, responsiveness and access, and financial contribution/health expenditure. Similar to the WHO framework, the OECD framework conducts health system performance assessment at both efficiency and equity levels. Overall, seven performance dimensions were emphasized: accessibility, patient experience, health expenditure, responsiveness, efficiency, health status improvement, and equity (Hurst & Jee-Hughes, 2001). With the implementation of the Health Care Quality Indicators Project in 2006, two more performance dimensions were added to the OECD Health System Performance Framework: effectiveness and safety (Kelley & Hurst, 2006).

OECD Proposed Health System Performance Framework		
	Average level	Distribution
Health improvement/outcomes (+)	✓	✓
Responsiveness and access (+)	✓	✓
Financial contribution/health expenditure (-)	✓	✓
	Efficiency	Equity

Adapted from Murray, C.J.L and Frenk, J. (2000)

Figure 25: The Proposed Health System Performance Framework for OECD Health Systems (Hurst & Jee-Hughes, 2001)

The Institute for Healthcare Improvement (IHI) spotlights the Triple Aim approach to quality improvement in health care. The goal of the IHI Triple Aim Initiative is to simultaneously improve the health of the population, enhance the experience and outcomes of the patient, and reduce per capita cost of care for the benefits of communities (IHI, 2014). Consequently, IHI's endeavour in performance measurement using the Triple Aim (see Table 6) focuses solely on three performance dimensions: health outcome, health expenditure, and patient experience (Stiefel & Nolan, 2012). One might argue that the focus on these three dimensions will suffice for quality improvement and performance measurement in health care. Additionally, the Triple Aim approach has seen success in many health organizations. The limitation of this approach remains its exclusion of 14 other commonly used performance dimensions.

Dimension of the IHI Triple Aim	Outcome Measures
Population Health	Health Outcomes: <ul style="list-style-type: none"> • Mortality: Years of potential life lost; life expectancy; standardized mortality ratio • Health and Functional Status: Single-question assessment (e.g., from CDC HRQOL-4) or multi-domain assessment (e.g., VR-12, PROMIS Global-10) • Healthy Life Expectancy (HLE): Combines life expectancy and health status into a single measure, reflecting remaining years of life in good health
	Disease Burden: Incidence (yearly rate of onset, average age of onset) and/or prevalence of major chronic conditions
	Behavioral and Physiological Factors: <ul style="list-style-type: none"> • Behavioral factors include smoking, alcohol consumption, physical activity, and diet • Physiological factors include blood pressure, body mass index (BMI), cholesterol, and blood glucose (Possible measure: A composite health risk assessment [HRA] score)
Experience of Care	Standard questions from patient surveys , for example: <ul style="list-style-type: none"> • Global questions from Consumer Assessment of Healthcare Providers and Systems (CAHPS) or How's Your Health surveys • Likelihood to recommend
	Set of measures based on key dimensions (e.g., Institute of Medicine's six aims for improvement: safe, effective, timely, efficient, equitable, and patient-centered)
Per Capita Cost	Total cost per member of the population per month
	Hospital and emergency department (ED) utilization rate and/or cost

Table 6: Triple Aim Outcome Measures (Stiefel & Nolan, 2012)

Studies and comparisons of health system performance measurement frameworks from the Commonwealth Fund Commission, WHO, OECD, and IHI have benefited the CIHI framework. The result of learning from other jurisdiction is CIHI's current extensive and comprehensive 17 performance dimensions. Other jurisdictions' experiences of measuring health systems performance have also been noted by CIHI. The knowledge gained from such comparisons has helped Canada when CIHI's Health System Performance Measurement Framework is implemented. Aligning provincial health systems' priorities, goals, and objectives to the CIHI performance measurement framework is critical.

Canadian National Performance Measures from CIHI

CIHI health indicators are standardized measures that help with comparisons in health status and health system performance in various jurisdictions in Canada. They also reflect on the characteristics of the health system and on disparity, which examines the socioeconomic status of the population. CIHI's list of performance measures is displayed via different vehicles for both internal and external users. As of July 2015, there are 110 indicators on the CIHI Indicator Library⁷. [Appendix C](#) contains these 110 CIHI performance indicators in relations to the performance dimensions outlined in its health system performance measurement framework, which was discussed in this section of the thesis. CIHI's public reporting website⁸ contains two views: In Brief and In Depth. The In Brief view holds 15 indicators showing performance information in an infographic format. The In Depth view contains 37 indicators with detail level information available in Microsoft Excel format for further analytical and operational purposes. This thesis makes Canadian national performance indicators available for review via the CIHI websites (see footnote). Knowing which performance measures are used at the national level can benefit regional planning in health system performance measurement efforts.

Alberta's Health System Outcomes and Measurement Framework

Many Canadian provinces have also established performance measurement frameworks to monitor provincial health system performance. This research chose Alberta's Health System Outcomes and Measurement Framework to study because Alberta's framework offers areas of inspiration for BC to follow. Alberta's framework shows a focus on health system sustainability

⁷ CIHI Indicator Library: <http://indicatorlibrary.cihi.ca/display/HSPIL/Indicator+Library?desktop=true>

⁸ CIHI's Your Health System website: <http://yourhealthsystem.cihi.ca/>

and provides a clear alignment with CIHI's framework. This section will discuss the performance measurement framework in Alberta.

Background

As Alberta's province-wide health authority, Alberta Health Services (AHS) was formed in 2008 amalgamating the former nine regional health authorities, the Alberta Mental Health Board, the Alberta Cancer Board, and the Alberta Alcohol and Drug Abuse Commission. The AHS is responsible for overseeing the planning and delivery of health supports and services through health professionals in fee-for-service practice and others who provide equipment, supplies, and services. To ensure all residents of Alberta have equal access to health services, the AHS Board governs all health services in the province, working in partnership with Alberta Health, which is Alberta's Ministry of Health. Alberta Health sets policy, legislation, and standards for the health system in Alberta. The Ministry allocates health funding, administers provincial health programs, and provides expertise on disease control (AHS, 2014a).

In 2012, Alberta Health introduced its Health System Outcomes and Measurement Framework to guide the selection and development of performance measures that are used to monitor achievements of the five strategies introduced by the provincial action plan, *Becoming the Best: Alberta's 5-Year Health Action Plan 2010-15* (AHS, 2010). The purpose of this framework is to provide a clear vision of health system success by identifying the outcomes Alberta's health system is expected to achieve, a logic model to achieve those outcomes, and measures for monitoring performance. These outcomes and measures will provide the basis for public reporting on Alberta's health system, with reporting showing both progress towards expectations and changes from previous performance (AHS, 2013).

Logic Model

The AHS framework shows a causal relationship between intended outcomes, outputs, activities, and inputs (see Figure 26). It follows Brown's (1996) *Input, Processes, Outputs and Outcomes Framework* (see Figure 17 on Page 40) and depicts the pathway through which resources are converted to expected results.

Attachment 1a: Alberta's Health System Outcomes and Measurement Framework

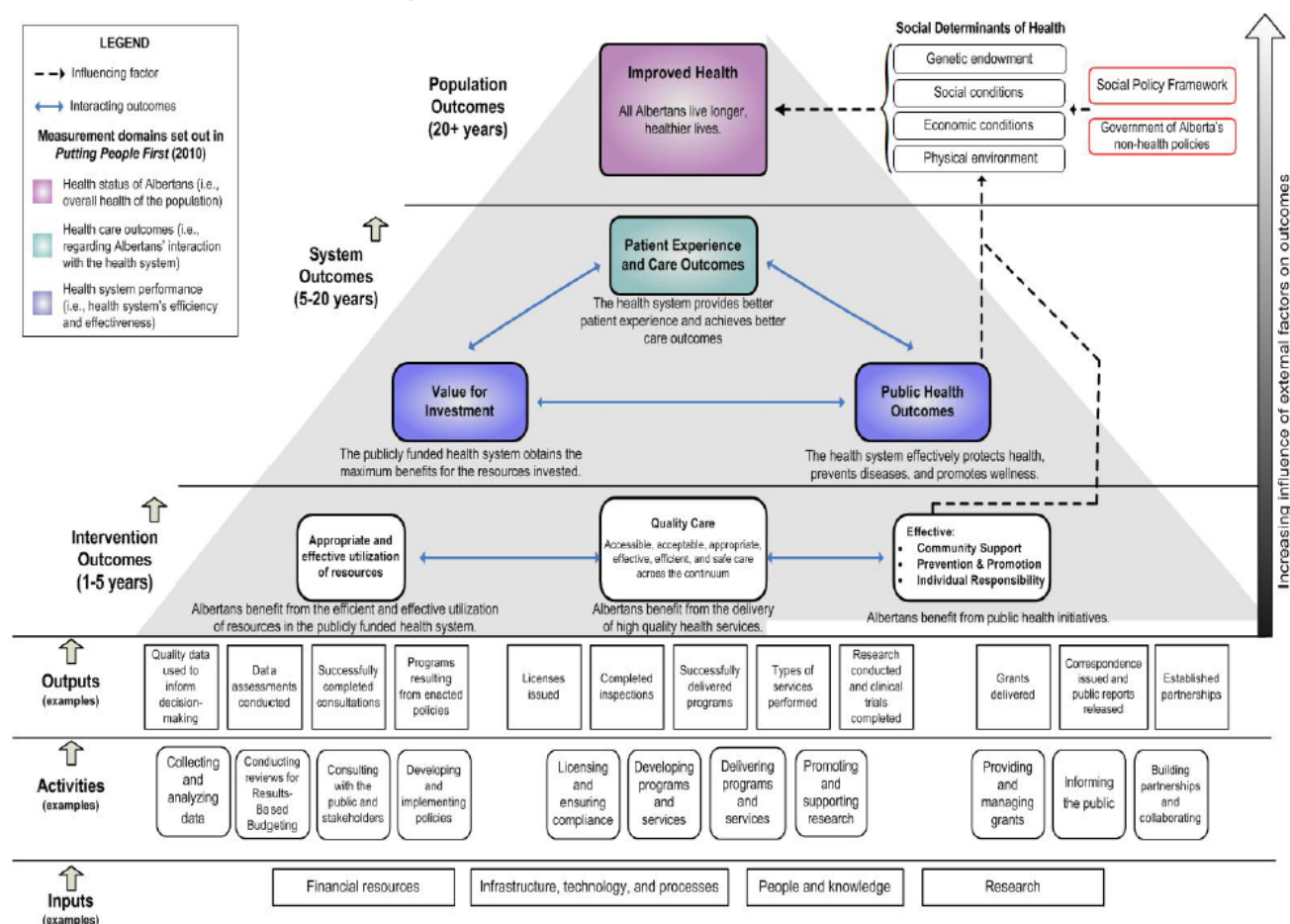


Figure 26: AHS Health System Outcomes and Measurement Framework (AHS, 2013)

Outcomes

AHS's Health System Outcomes and Measurement Framework presents an opportunity to raise awareness on expected outcomes for the provincial health system and the necessary

efforts to achieve these outcomes. Outcomes are often consequences of policies, services, programs, and major initiatives. Alberta's framework groups outcomes into three cascading categories:

1. **Population outcomes:** The expected outcome of Alberta's health system is to improve the health status of Alberta residents. These outcomes reflect changes at the population level and require a long-term commitment. Significant changes in population outcomes might take up to twenty years to appear.
2. **System outcomes:** Improved population health builds on the attainment of system outcomes. This framework identifies three systems outcomes: value for investment, patient experience and care outcomes, and public health outcomes. Changes at the system level are expected to take place within five to twenty years.
3. **Intervention outcomes:** As population outcomes depend on the achievement of system outcomes, system outcomes build on the success of intervention outcomes. This framework identifies three intervention outcomes: appropriate and effective utilization of resources; quality of care; and effective community support, individual responsibility, and prevention and health promotion. Intervention outcomes are the direct result of services and programs and are expected to be realized within one and five years.

As shown visually in the logic model, the influence of external factors on outcomes increases from intervention outcomes to system outcomes to population outcomes (AHS, 2013).

Outputs, Activities, and Inputs

Much like the cascading dependence relationship among the three outcomes, intervention outcomes depend on outputs from policies and strategic initiatives. Outputs are the direct

product of services resulting from activities, which in turn require a set of inputs of resources such as finance, people, technology, and knowledge (AHS, 2013).

Measures

Measures included in the framework are applied in areas such as performance accountability, target setting, and population health to assess the effectiveness of the health system performance in affecting intended outcomes. The measures are also categorized into four macro-level domains and subsequent dimensions for each domain (see Figure 27). The four domains – population health, health services delivery, governance and community engagement, and health system sustainability – represent the four major areas of overall importance selected to measure the performance of Alberta’s health system. Performance measures are grouped under dimensions beneath each domain for more focused measurement unique to that domain.

<i>Population Health</i>							
Well-Being	Health Conditions	Human Function	Death	Health Behaviours	Living and Working Conditions	Personal Resources	Environmental Factors
<i>Health Services Delivery</i>							
Acceptability	Accessibility	Appropriateness	Effectiveness	Efficiency	Safety		
Health services are respectful and responsive to user needs, preferences and expectations.	Health services are obtained in the most suitable setting in a reasonable time and distance.	Health services are relevant to user needs and are based on accepted or evidence-based practice.	Health services are provided based on scientific knowledge to achieve desired outcomes.	Resources are optimally used in achieving desired outcomes.	Mitigate risks to avoid unintended or harmful results.		
<i>Governance and Community Engagement</i>							
Governance		Community Engagement			Accreditation		
<i>Health System Sustainability</i>							
Health Technologies		Health Workforce		Information Management/ Information Technology		Fiscal Efficiencies	

Figure 27: AHS Measurement Classification Approach (AHS, 2013)

This measurement classification approach aligns with CIHI's method in the classification of performance measures and can also be used to assist in gap analysis for more focused measurement.

A set of 12 health system outcome measures (see [Appendix D](#)) have been identified to support and contribute to the Minister's public reporting strategy on health system performance towards intended outcomes and to benchmark Alberta's performance against other jurisdictions. These 12 measures were selected based on criteria including jurisdictional comparability, data availability, system level outcomes focus, and a balanced Triple Aim approach, and provide the basis for performance planning and public reporting. The 12 health system outcome measures serve as a foundation for the development and selection of a second layer of strategic performance measures, which are linked primarily to intervention outcomes.

Strategic performance measures include population indicators and accountability measures. Population measures represent a shared area of responsibility between Alberta Health and its agencies and have a critical role in monitoring the health system. Accountability measures direct agencies to focus on areas where results are both desirable and needed, demonstrate progress towards expectations, and examine changes from previous performance. They are selected to affect the outcomes of key priorities set jointly by Alberta Health and its agencies, reflect areas where significant investment is made, and are intended to be foundational to other emerging health system strategies. It is the expectation that agencies will link their organizational strategic performance measures to province-wide accountability measures and use such linkage to form the basis of performance planning accountability reporting to the Minister.

Reporting

AHS's accountabilities cascade (see Figure 28) illustrates the measures hierarchy, appropriate audience, and reporting frequency. As mentioned previously, the 12 health system outcome measures reflect the concerted efforts by the entire health system and can enable the obligations for public reporting on the health system performance. The strategic performance measures are to be recommended as the basis of health care system strategic and business planning, performance assessment, and accountability reporting. Future endeavours will be focused on developing additional performance measures for both tactical and transactional measures with cascading accountabilities for these level-specific measures. Such measures will reach further into affected organizations, meet requirements of different audiences, and have different reporting timelines.

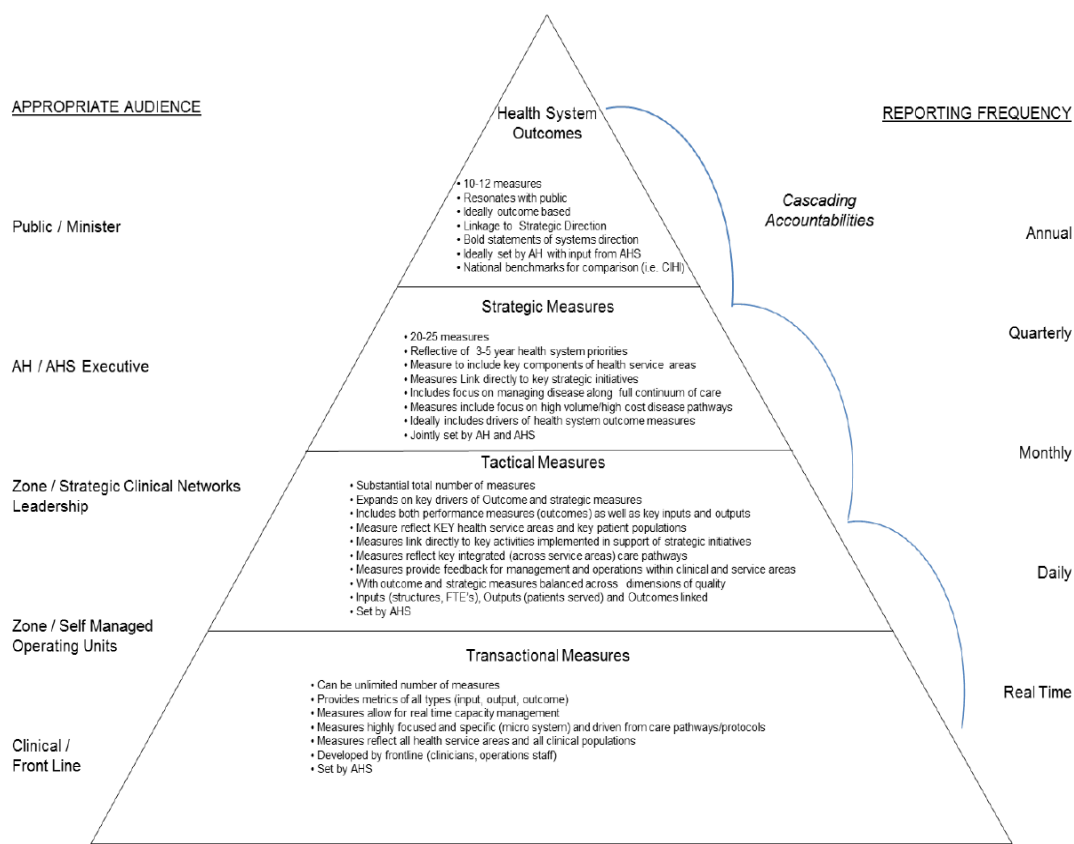


Figure 28: AHS's Cascading Accountabilities (AHS, 2013)

2.2.3 Current Status in British Columbia

In BC, the Ministry of Health has overall responsibility for measuring, monitoring, and reporting on how well the provincial health system is performing. The Ministry works with the five regional health authorities and one provincial health authority to ensure quality, appropriate, and timely health services are available to all residents in BC. It is an ongoing effort for the Ministry and the six health authorities to measure population health outcomes and monitor health system performance.

BC Ministry of Health

Priority #2 in the BC Health System Strategy points to the BC Guiding Framework for Public Health: *Promote, Protect, Prevent: Our Health Begins Here* (the Guiding Framework). This framework (see Figure 29) aims to direct public health practitioners and managers to improve the population's health and well-being by:

- Creating a long-term vision for the public health system, which incorporates all pre-existing major public health strategies.
- Formalizing a collaborative process to identify future public health priorities.
- Reinforcing core public health functions as the foundation for public health services.
- Supporting a population health approach and the public health role in health equity.
- Connecting to and supporting self-care, primary care, and clinical prevention (BC Ministry of Health, 2013b).

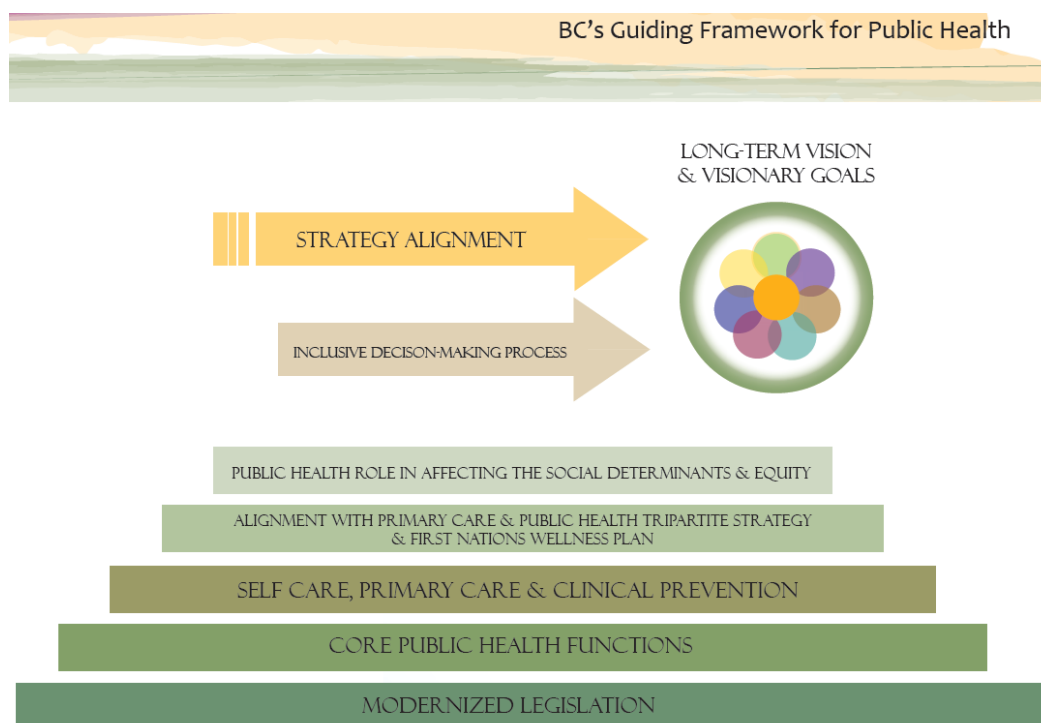


Figure 29: BC's Guiding Framework for Public Health (BC Ministry of Health, 2013b)

In BC, public health has an enabling role in population health improvement. Public health helps decision makers investigate causes of good and poor health and provide services and interventions for those causes to improve the health of the population. Public health services can prevent disease and injury, protect the population from chronic conditions, and promote healthy behaviours and environment. The BC Public Health Strategic Framework (see Figure 30), which was established in 2003, is the foundation of the Guiding Framework. The Strategic Framework outlined the four public health strategies: health promotion, health protection, preventive interventions, and health assessment and surveillance (BC Ministry of Health, 2013b). These four strategies guide the implementation of BC public health core programs in areas of health improvement; prevention of disease, illness, and injury; environmental health; and public health emergency management.

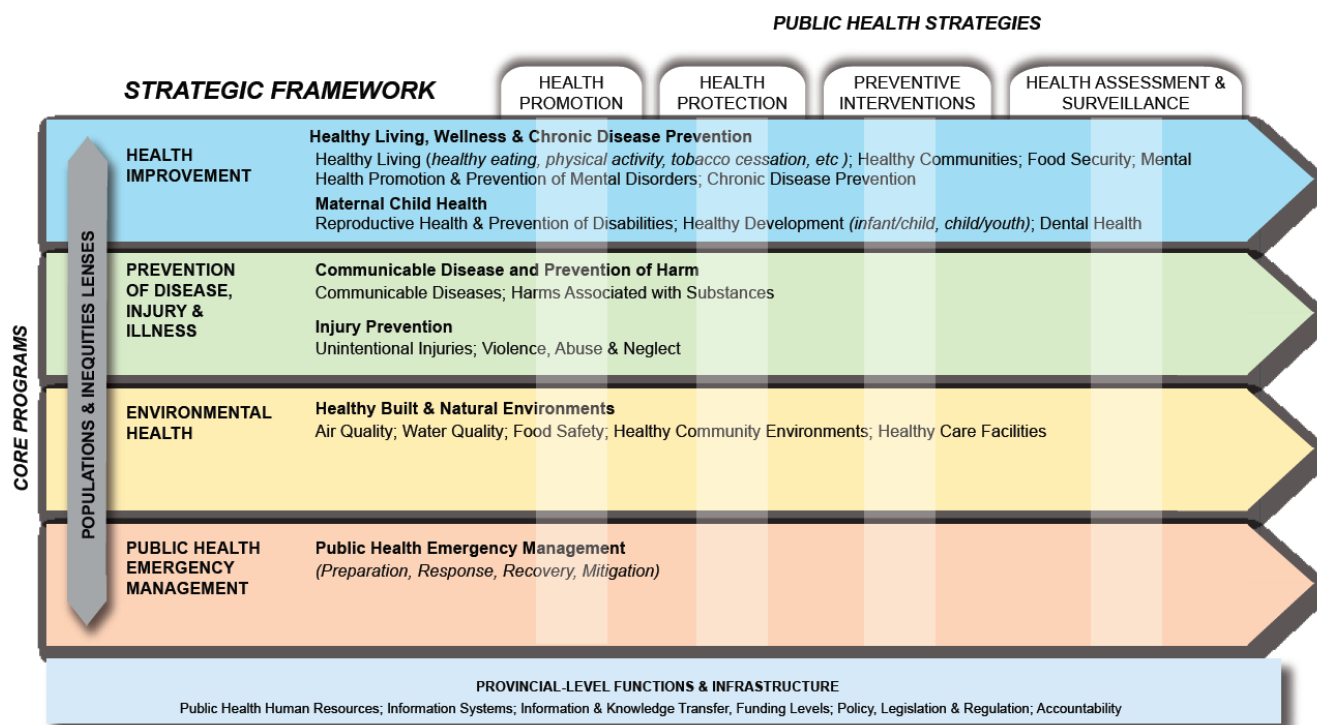


Figure 30: BC's Public Health Strategic Framework (BC Ministry of Health, 2013b)

The Guiding Framework introduces seven visionary goals for the BC public health system and emphasizes on the alignment of public health strategies to the seven goals. Figure 31 shows the seven goals identified in the guiding framework. Performance measures (see [Appendix E](#)) are selected for each of the seven goals and reported in the Guiding Framework. These goals support BC public health system's vision: "Vibrant communities in which all people achieve their best health and well-being where they live, work, learn and play." (BC Ministry of health, 2013b, p. 17)

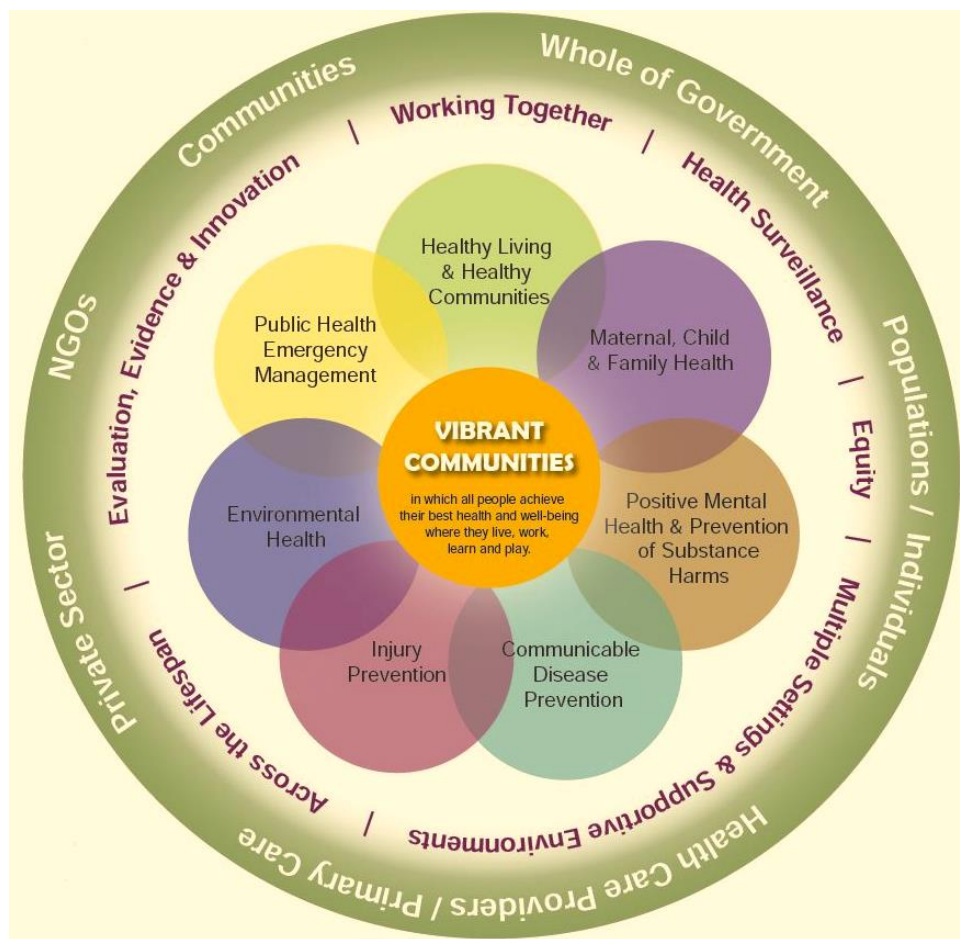


Figure 31: Seven Visionary Goals in the Guiding Framework (BC Ministry of Health, 2013b)

The Guiding Framework for Public Health in BC offers an in-depth examination of how the public health system is performing based on results of 25 measures from the seven goals. The framework outlines current actions and projects in the province to achieve these goals. BC's baseline, targets, and trends are also discussed in the framework document (BC Ministry of Health, 2013b).

Under the newly established *Taxpayer Accountability Principles* (2014), all provincial public sector organizations are expected to promote cost control, strengthen accountability, and make sure all corporate functions are operated in the best interest of taxpayers. [Appendix F](#) displays the six taxpayer accountability principles in BC. Public reporting becomes a common

method for BC health organizations to report on progress and performance in the health industry. This section includes all performance indicators that are available via public reporting from the Ministry as well as the six BC health authorities.

The four Ministry of Health FY2014/2015 Service Plan performance measures (see Table 1, Page 9) show how the BC health system is doing in the accessibility and effectiveness performance dimensions. For example, the “A GP for Me” initiative aims to increase access to primary care so that the needs of patients are met in communities and not in hospitals. In 2013, 65 percent of the residents in BC were attached with a General Practitioner (GP) or to GP practice. The target in 2014 is 75 percent, 80 percent for 2015, and by 2016, BC will aim to have 85 percent of its population attached to either a specific GP or GP practice. The Ministry sets targets for each measure and communicates the targets to the health authorities. This indicator helps the Ministry to investigate results directly affected by GP services whether chronic conditions are effectively prevented and managed, admissions to hospitals and residential care facilities are reduced, and the need for health services is addressed in community in a timely fashion.

At the regional level, the five health authorities report on the performance of the BC health system using both Ministry Service Plan measures and their own indicators. Various forms of public reporting are used to publish health authority performance findings at the regional level. [Appendix G](#) lists all five health authorities’ public reporting performance measures that are available to the public as of FY 2013/2014.

Vancouver Island Health Authority

Vancouver Island Health Authority (VIHA or Island Health) reports performance measures (see [Appendix G](#)) in areas such as quality and patient safety, patient flow, wait times,

work life, finance, and patient care model monitoring (VIHA, 2014). Each measure relates to strategies and goals listed in the Island Health Strategic Plan, which is aligned with the goals, priorities, and strategies outlined in Ministry's health system strategy. An example of the Ambulatory Care Sensitive Conditions (ACSC) measure on Island Health's public reporting website can be reviewed in Appendix G.

Vancouver Coastal Health Authority

Vancouver Coastal Health Authority (VCHA) applies the Scorecard approach to measure system performance against its strategic goals (VCHA, 2014). The VCHA public reporting performance measures are grouped by its four strategic goals: provide the best care, promote better health for communities, develop the best workforce, and innovate for sustainability. Grouped under the four strategic goals, the 24 performance measures (see [Appendix G](#)) are designed to demonstrate where VCHA is doing well and where the organization is working to make improvements. The full report card provides answers to these questions: what VCHA is measuring, why measurement matters, how VCHA measures it, how VCHA is doing, and what VCHA is doing to maintain or improve performance. An example of VCHA's health care report card on the surgery wait time longer than 52 weeks measure can be reviewed in [Appendix G](#).

Fraser Health Authority

The BC Health Minister, Terry Lake, released the strategic and operational report of Fraser Health Authority (FHA) in July 2014 (FHA, 2014a). After concluding the yearlong extensive Fraser Health Review, which started in early 2013, Fraser Health board identified 10 priority action areas to address issues facing the health authority from quality concerns to achieving balance among acute, primary, and community care.

Unlike VIHA and VCHA including performance measures in the Accountability section on their public website, FHA publishes system performance measures in both its Health Authority Service Plan and the Strategic and Operational Plan. The Fraser Health Authority Service Plan contains five performance measures categorized under the provincial goals and objectives stated in the Ministry's health system strategy (see [Appendix G](#)).

In the 10 priority actions outlined in the *Fraser Health Strategic and Operational Plan for 2014/15 – 2016/17*, the fourth priority, Accountability, stated, “[Fraser Health Authority] will create a balanced scorecard of key performance measures and will report quarterly at the health authority, health service delivery area and site level” (FHA, 2014a, p. 66). FHA's scorecard will be a main performance reporting document for the health authority. The strategic and operational plan also listed the six Pay for Performance measures (Emergency admission from triage, Elective patients waiting greater than 52 weeks for surgery, Hip fracture fixations within 48 hours, Nursing-sensitive adverse events, Home and community care data compliance, and Long length of stay) for the health authority. If measurement targets are not achieved by fiscal year end, a total amount of \$12.05 million dollars could be held back from the health authority (FHA, 2014a, p. 74). Figure 40 demonstrates information on the home support utilization rate by year measure in FHA.

Interior Health Authority

Interior Health Authority (IHA) takes a similar approach as FHA and includes its performance measures in its Health Authority Service Plan to the Ministry of Health (IHA, 2013). The Service Plan is updated annually and outlines the three-year plan from IHA to achieve its organizational goals and objectives. Performance measure groupings under goals and objectives in IHA can be reviewed in [Appendix G](#). Goals from the IHA are aligned with the

Ministry strategic goals to address health outcomes, system sustainability, and value for money (IHA, 2013).

Northern Health Authority

Northern Health Authority (NHA) also reports its performance measures (see [Appendix G](#)) in its Health Authority Service Plan. The *Northern Health 2013/14 – 2015/16 Service Plan* is published under the financial accountability section and outlines its four strategic directions: a population health approach, integrated accessible health services, high quality services, and a focus on people in the NHA (NHA, 2013). The four NHA strategic goals aligned with the strategic goals from the Ministry.

Provincial Health Services Authority

Provincial Health Services Authority (PHSA) announced in 2010 its strategic directions and objectives in the publication of *PHSA Strategic Plan 2010 – 2013*. PHSA reports system performance measures to the Ministry of Health and the public via its Health Authority Service Plan. The *PHSA Service Plan 2013/14 – 2015/16* is published under the Budget & Financials section on PHSA's public website and includes the six performance measures (see [Appendix G](#)), which aim to report performance for the three PHSA corporate strategic directions as well as the goals and objectives from the Ministry (PHSA, 2013).

As participants in the provincial public reporting initiative, some health authorities communicate the performance and impacts of their services to the public via both Ministry-provided and health authority internal performance measures. Other health authorities report results on Ministry-provided indicators directly to the Ministry of Health via annual health

authority service plans. There is a good alignment and coverage of the performance dimensions in the total 11 measures in BC. To summarize, these measures are displayed in Table 7.

Measure	MoH (2014/15)	VIHA (2013/14)	VCHA (2013/14)	FHA (2014/15)	IHA (2013/14)	NHA (2013/14)	PHSA (2013/14)
Percent of family physicians participating in the “A GP for me” full service family practice initiative. <i>Performance dimension: Accessibility</i>	√						
Percent of communities that have completed health living strategic plans. <i>Performance dimension: Accessibility</i>	√	√	√	√	√	√	
Number of people with a chronic disease admitted to a hospital (per 100,000 people aged less than 75 years). <i>Performance dimension: Effectiveness</i>	√	√	√	√	√	√	
Percent of people aged 75+ receiving home health care and support. <i>Performance dimension: Accessibility</i>		√	√	√	√	√	
Percent of non-emergency surgeries completed within the benchmark wait time. <i>Performance dimension: Accessibility</i>	√	√	√	√	√	√	
Nursing overtime hours as a percent of productive nursing hours. <i>Performance dimension: Efficiency</i>		√	√	√	√	√	√
Percent of women aged 50-69 years participating in screening mammography once every two years. <i>Performance dimension: Accessibility</i>							√
Percent of dialysis patients on independent dialysis modalities (peritoneal dialysis & home haemodialysis). <i>Performance dimension: Accessibility</i>							√
Percent of children admitted to an inpatient psychiatric unit bed within 42 days. <i>Performance dimension: Accessibility</i>							√
Percent of non-emergency complex paediatric hip surgery completed within established benchmarks. <i>Performance dimension: Accessibility</i>							√
Percent of women with previous C-section births who plan to have a vaginal delivery. <i>Performance dimension: Appropriateness</i>							√

Table 7: Summary Table of Ministry and Health Authority Service Plan Performance Measures

The availability of most up-to-date performance indicators on health authorities' websites varies. Hence, measures from different fiscal years are included in Table 7. Although they are not from the same fiscal year, they align with measures from the current fiscal year and suffice for the present purpose. A subset of publicly reported health system performance measures in BC are displayed in Table 7. Each indicator is assigned with a performance dimension that can be matched with the five quality dimensions identified by the BC Patient Safety & Quality Council (BCPSQC). These five quality dimensions (see Figure 32) are also adopted by the BC Ministry of Health in its Health System Strategy to deliver quality health services. The Health Quality Matrix from BCPSQC is discussed in the next section. As shown in Table 7, having eight out of 11 indicators, the accessibility domain seems to be the current focus area in the BC health system performance measurement and reporting at the strategic level.

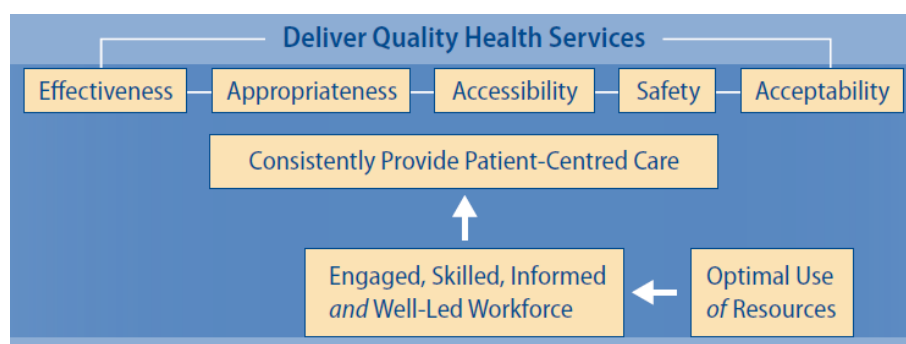


Figure 32: Quality Dimensions in the BC Health System Strategy (BC Ministry of Health, 2014b)

British Columbia Health Quality Matrix

Established in 2008, the BC Patient Safety & Quality Council (the Council) is sponsored by the provincial government and aims to enhance patient safety, reduce errors, promote transparency, and identify best practices to improve patient care (BCPSQC, 2012). Since its creation, the Council has provided invaluable advice to the Ministry of Health on patient safety and quality of care issues. The Council also supports a wide spectrum of initiatives such as BC

Sepsis Network, Surgical Quality Action Network, Safer Healthcare Now, and Board & Executive Learning Series (BCPSQC, 2014).

The BC Health Quality Matrix was a product of a consultation process with representatives from health care communities throughout the province in 2009 (BCPSQC, 2012). This approach has also been modelled on the work done by health quality councils from Alberta and Saskatchewan. The Health Quality Matrix is a framework to provide a common language and understanding about health care quality among various health organizations. The Council states that the BC health quality matrix can be used by health care delivery organizations for “strategic planning, quality improvement program planning, measurement, and evaluation at a program, facility, and system-wide level.” (BCPSQC, 2012, p. 1)

As shown in Figure 33, the BC Health Quality Matrix contains five dimensions of quality addressing the delivery of health services among four areas of care and two dimensions of quality measuring the performance of the health system. This Matrix can be used to measure quality. Other factors of quality such as leadership, staff engagement, patient empowerment, and information systems are not included in this matrix because they are foundational to having a safe and high quality health system (BCPSQC, 2012).

BC Health Quality Matrix

	DIMENSIONS OF QUALITY				
	ACCEPTABILITY	APPROPRIATENESS	ACCESSIBILITY	SAFETY	EFFECTIVENESS
AREAS OF CARE	Care that is respectful to patient and family needs, preferences, and values	Care provided is evidence based and specific to individual clinical needs	Ease with which health services are reached	Avoiding harm resulting from care	Care that is known to achieve intended outcomes
STAYING HEALTHY Preventing injuries, illness, and disabilities					
GETTING BETTER Care for acute illness or injury					
LIVING WITH ILLNESS OR DISABILITY Care and support for chronic illness and/or disability					
COPING WITH END OF LIFE Planning, care and support for life-limiting illness and bereavement ⁴					
	EQUITY Distribution of health care and its benefits fairly according to population need EFFICIENCY Optimal use of resources to yield maximum benefits and results DIMENSIONS OF QUALITY				

⁴ Descriptor reflects direction of the Ministry of Health and input from the Provincial End of Life Standing Committee.

In 2008, the BC Health Quality Matrix was developed in collaboration with the members of the Health Quality Network which included BC's Health Authorities, Ministry of Health Services, academic institutions and provincial quality improvement groups and organizations.

www.bcpsqc.ca

Figure 33: BC Patient Safety & Quality Council's Health Quality Matrix (BCPSQC, 2012)

The seven dimensions of quality on the horizontal axis in the Health Quality Matrix can be summarized in Figure 34.

Five Dimensions of Quality are focused on the patient/client experience from both an individual as well as a population perspective:	
Acceptability:	Care that is respectful to patient and family preferences, needs and values
Appropriateness:	Care that is provided is evidence-based and specific to individual clinical needs
Accessibility:	Ease with which health services are reached ³
Safety:	Avoiding harm resulting from care
Effectiveness:	Care that is known to achieve intended outcomes

Two Dimensions of Quality measure the performance of the system in which health care services are delivered:	
Equity:	Distribution of health care and its benefits fairly according to population need
Efficiency:	Optimal use of resources to yield maximum benefits and results

Figure 34: BC Patient Safety & Quality Council's Seven Dimensions of Quality (BCPSQC, 2012)

Also, the four areas of care on the vertical axis can be summarized in Figure 35.

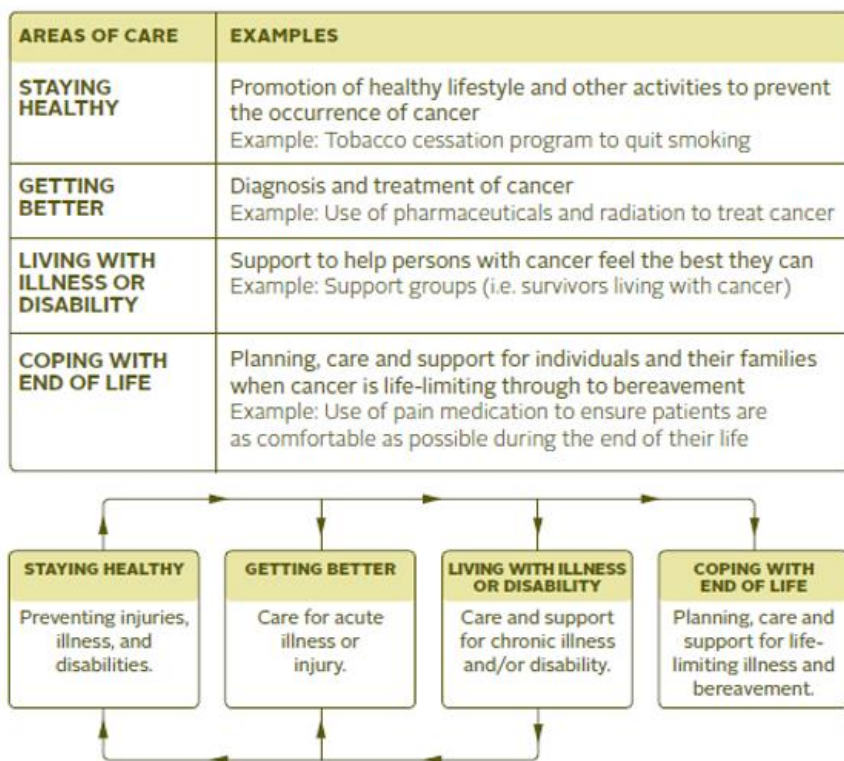


Figure 35: BC Patient Safety & Quality Council's Four Areas of Care (BCPSQC, 2012)

The Council uses the BC Health Quality Matrix for its own planning, assessment, and evaluation purposes. Despite its internal use, the framework is designed for every level of BC health system including government, executive management, health service provider, and even individual patients. The Matrix cells, where dimensions of quality and areas of care meet, highlight the interrelatedness of quality dimensions and health responsibilities as the areas of care shift according to changing patient needs. The Council has shown excellent examples of how the Health Quality Matrix was used in program planning (planning BC Healthlink's 8-1-1 service, p. 8), quality improvement activities (surgical measurement and quality in BC, p. 10), and success evaluation (Evaluating the success of BC HPV (Human Papillomavirus) program, p. 12) (BCPSQC, 2012).

Section 2.2 reviews the development of first and second generations of performance measurement systems, the Canadian sample health system performance measurement frameworks, and current publicly available performance measurement information in BC. Table 6 (on Page 54) shows the comprehensive coverage of 17 performance dimensions in the CIHI framework when compared to four international performance measurement frameworks. Alberta's framework offers areas of improvement for BC: aligning its measurement classification approach to the national approach; needing an upgrade in its performance measurement system from the first to second generation; and categorizing performance measures for the relevant audience. The BC performance measurement endeavours from the public health sector and the six health authorities are also reported.

AHS' measurement classifications (see Figure 27 on Page 62) follows CIHI's performance dimensions from population health to service delivery to community engagement. Although only the BC Guiding Framework for Public Health is publicly available, BC can learn

from Alberta to align performance measurement dimensions to the CIHI framework. AHS' framework belongs to the first generation performance measurement system because it matches with the structure of Brown's (1996) *Input, Processes, Outputs and Outcomes Framework*. This highlights the need to transform the current system to the second generation for a better measurement of health system performance. One of the purposes of collecting performance data for measurement is to report system performance to relevant audiences. Alberta shows a clear categorization of appropriate audience, and its performance measures are grouped under a cascading accountabilities (see Figure 28 on Page 64). BC could benefit from such categorizations of both performance measures and audiences.

With an increased level of familiarity and understanding of national and provincial performance measurement practices, the next section discusses systems approaches, systems theory, and system dynamics.

2.3 Systems Approach

A system is a set of “elements standing in interaction” (Bertalanffy, 1968, p. 38). Interactions among system elements form patterns of behaviour, which create events that external parties can observe (Kirkwood, 1998). There are many types of systems: organisms (animals and humans), machines (computer systems), physic-chemical systems, social systems and more. Systems scientists point out that the structure of a system determines system behaviours and a change in one part of the system will lead to changes in all parts of the system (Hanson, 1995). Each system’s specific structure is made up of interdependent relationships among system components and forms “irreducible characteristics of its own” (Laszlo, 1932, p. 9). Systems scientists stress that to fully understand a system it is essential to examine it as a whole with its own characteristics and properties.

Systems approach is different from traditional approaches because the emphasis is on the interrelatedness of system components rather than the characteristics of individual parts within the system. A reductionist would concentrate on the details and neglect the structure, thereby ignoring the contextual information a system as a whole might provide. A systems scientist, on the other hand, would examine system structure on all levels of complexity and then consider details with feedbacks to its holistic framework. Systems scientists study system structures and relationships to understand how events and behaviours are generated. Conversely, reductionists tend to study system events and behaviours first to gain understanding of how systems are structured and what relationships they might find (Laszlo, 1932).

2.3.1 Systems Theory

Systems theory is an interdisciplinary science that has the comparative study of systems in general as its object (Stichweh, 2011). The history of systems theory can be traced back as early as the pre-Socratics of the sixth century B.C. Aristotle's statement, "The whole is more than the sum of its parts," is one of the starting points of forming holistic and teleological notions for solving system problems (Bertalanffy, 1972, p. 407). Systems theory was further developed in academia after the 1940s and established its foundation in other disciplines such as biology (Ludwig von Bertalanffy), physiology (Walter Cannon and Warren McCulloch), and cybernetics (Claude Shannon, Norbert Wiener, and William Ross Ashby) (Stichweh, 2011). Contemporary systems theory originates from Bertalanffy's General System Theory in biology and was later used in other fields such as sociology, psychology and engineering. As a comparative research program for heterogeneous types of systems, systems theory applies a highly generalized concept of systems, emphasizes holism over reductionism and organism over mechanism, and has the following assumptions:

- The interdependence of the parts of a system forms the structure of the system.
- Continuous equilibrium amongst the interrelated parts and adaptations to environmental demands are core elements for understanding of a system.
- The reference of any structure and process within a system connects to the environments of the system.
- Self-organization of a system is the principle way it responds to external interventions.
- As a trigger mechanism for system formation, complexity describes the internal network structures of connectedness among system elements (Stichweh, 2011, p. 2580).

Systems theory can provide holistic solutions for this research in understanding the BC health system fully to support a sustainable health service delivery system. Achieving or maintaining a sustainable health system requires a full understanding of how internal system processes interact with each other and how the system is influencing or being influenced by external environments.

2.3.2 System Dynamics

According to Jackson (2003), there are 10 systems approaches that are commonly applied in management science. These systems approaches can be grouped into four types: Improving Goal Seeking and Viability, Exploring Purposes, Ensuring Fairness, and Promoting Diversity (see Table 8). Studying these systems approaches helps to identify the most appropriate approach to adopt. Since developing a performance measurement model to achieve health system sustainability is the goal for this research, a systems approach from the Improving Goal Seeking and Viability category seems reasonable to use. The background, method, application, and critiques of the system dynamics approach will be discussed in this section.

Types	System Approaches
A. Improving Goal Seeking and Viability	1. Hard Systems Thinking
	2. Organizational Cybernetics
	3. Complexity Theory
	4. System Dynamics: The Fifth Discipline
B. Exploring Purposes	5. Strategic Assumption Surfacing and Testing
	6. Interactive Planning
	7. Soft Systems Methodology
C. Ensuring Fairness	8. Critical Systems Heuristics
	9. Team Syntegrity
D. Promoting Diversity	10. Postmodern Systems Thinking

Table 8: A Categorization of Systems Approaches (Jackson, 2003)

System dynamics is a method to enhance learning in complex systems via the use of diagrams as a vehicle to translate mental models and discuss changes (Sterman, 2000). This approach is useful because it provides a less ambiguous and more concentrated form of communication than a written description can provide. This systems approach helps managers understand the operations of feedback processes at the deep structural level that produce system behaviours at the surface level. The primary focus of system dynamics is on how policy determines behaviour and how effective policy design can lead to improved behaviour (Al-Alusi, 1988).

History of System Dynamics

Jay Wright Forrester developed system dynamics (SD) in 1956 to extend the range of applied systems thinking to business and management problems (Forrester, 1989). It was a major breakthrough for decision makers. With a background in computer sciences and control engineering, Forrester directed the System Dynamics Program at the MIT (Massachusetts Institute of Technology) Sloan School of Management from 1956 to 1989 (Jackson, 2003). During his 33 years with the MIT Sloan School, Forrester published several revolutionary books:

Industrial Dynamics (1961), *Principles of Systems* (1968), *Urban Dynamics* (1969), and *World Dynamics* (1971). These works transformed the way managers solve problems and provided examples on how servomechanism⁹ theory could be adapted to understand complex, puzzling, and counter-intuitive behaviours in human systems (Forrester, 1956). In his book *World Dynamics*, Forrester (1971) identified five basic parameters as representative of the world (population, natural resources, industrial production, agricultural production, and pollution) and studied their behaviours and interactions. Forrester and his colleagues designed a world system model (see [Appendix H](#)) to demonstrate that global economic growth at current levels was unsustainable. Forrester used the world system model to show how rapid economic growth should be limited to avoid environmental pollution or depletion of natural resources. The model also proposed ways to transit from limiting growth to a global equilibrium.

Most organizational problems are ill-defined or not clear. Focusing only on well-defined problems, hard systems thinking might not be the best choice to use for investigating unclear organizational problems. For example, the reason why some corporations succeed and some fail is not apparent. Forrester explained the system dynamics approach can be applied to explore soft or social causes of the problem. The following three basic ideas from the system dynamics methodology can help decision makers to comprehend corporate success and failure:

- Existing variables in complex systems become causally related in feedback loops,
- The systemic interrelationships between feedback loops constitute the structure of the system, and

⁹ A servomechanism is a self-regulating feedback mechanism that controls the performance of the system based on automatic feedback signals generated by the comparison of system outputs and reference inputs (Forrester, 1956). Examples of servomechanism include air conditioning, a car's cruise control, and Global Positioning System (GPS).

- The structure of the system is the prime determinant of system behaviour (Jackson, 2003).

Following Forrester's footsteps in establishing system dynamics as a well-respected systems approach, Peter Senge (1990) popularized the approach under the name "Systems Thinking" with his book *The Fifth Discipline: the Art and Practice of the Learning Organization*. Senge focused on system dynamics' ability to promote organizational learning. He outlined four core disciplines to build a learning organization: personal mastery, mental models, shared vision, and team learning. He emphasized that organizations will only excel if they incorporate the four core disciplines in their corporate culture and use them to discover people's commitment and capacity to learn at all levels in an organization. The four core disciplines explained briefly are:

1. Personal mastery is the discipline of continually progressing one's personal growth and development. It means a special level of proficiency in one's skills.
2. Mental models are deeply ingrained assumptions, pictures, or generalizations of the world that influence how people understand the world and how they take actions.
3. A shared vision involves the skills to discover shared perception of the future that encourage commitment rather than compliance.
4. Team learning can produce extraordinary results and ameliorate individual member's professional growth (Senge, 1990).

Systems thinking, as the fifth discipline, integrates all four other disciplines, enhances each one of them, and illustrates the idea from Bertalanffy's general system theory that the whole is greater than the sum of its parts.

Senge's work in endorsing systems thinking is an exceptional example of recent developments in the field of system dynamics. It proves that system dynamics is not just a rigid theory of causes and effects. System dynamics, as a contemporary adaptation of the systems

thinking philosophy, can be used to interpret systems' deep structural patterns that provide insights on system behaviours. Insights gained from applying the system dynamics approach will enable managers to discover appropriate solutions to system-wide problems.

Method

As the founder and inventor of system dynamics, Forrester (1961, 1971) developed a five-step system dynamics method: problem structuring, causal loop diagramming, dynamic modeling, scenario planning and comparing, and implementation and organizational learning. This was the original five-step method of system dynamics. Since the 1960s, the SD method was adapted into different industries. Many developers have altered this method into something more suitable for their own processes.

In his book *System Enquiry A System Dynamics Approach*, Wolstenholme (1990) divides Forrester's five-step method into two phases: qualitative and quantitative (see Table 9).

Qualitative System Dynamics (Diagram construction and analysis phase)	Quantitative System Dynamics (Simulation phase)	
To create and examine feedback loop structure of systems using resource flows, represented by level and rate variables and information flows, represented by auxiliary variables.	Stage 1	Stage 2
To provide a qualitative assessment of the relationship between system processes (including delays), information, organizational boundaries and strategy.	To examine the quantitative behaviour of all system variables over time.	To design alternative system structures and control strategies based on <ol style="list-style-type: none"> 1. Intuitive ideas. 1. Control theory analogies. 2. Control theory algorithms.

		In terms of non-optimising robust policy design.
To estimate system behaviour and to postulate strategy design changes to improve behaviour.	To examine the validity and sensitivity of system behaviour to changes in <ol style="list-style-type: none"> 1. Information structure 2. Strategies 3. Delays/uncertainties 	To optimise the behaviour of specific system variables.

Table 9: System Dynamics - A Subject Summary (Wolstenholme, 1990)

According to Wolstenholme, SD is a qualitative description and exploration of complex systems for analyzing system processes, information, boundaries, and strategies, which “facilitates quantitative simulation modeling and analysis for the design of system structure and control” (Wolstenholme, 1990, p. 3). Although there is no clear dividing line between qualitative and quantitative system dynamics, qualitative system dynamics (QSD) can be applied as a separate methodology for systems description and model analysis outside the domain of computer simulation. Wolstenholme stated qualitative system dynamics has three purposes:

1. To create and examine the feedback loop structure of systems using resource flows, represented by level and rate variables and information flows, represented by auxiliary variables.
2. To provide a qualitative assessment of the relationship between system processes (including delays), information, organizational boundaries, and strategy.
3. To estimate system behaviour and to postulate strategy design changes to improve behaviour (Wolstenholme, 1990).

The qualitative system dynamics methodology contains two phases. The first phase is to describe the system and understand the problem so that an initial interpretation of the system can

be constructed into a mental model, which can offer greater value than words. This mental model is also referred to as influence or causal loop diagram. The second phase involves the qualitative analysis of derived diagrams. Wolstenholme has outlined four steps for the second phase:

- 1) Static analysis of the model structure
- 2) Identify control issues
- 3) Dynamic implications of the model structure
- 4) Identify factors likely to lead to improved system performance (Wolstenholme, 1985)

A complete list of steps for the QSD methodology can be reviewed in [Appendix I](#).

This research will adapt Wolstenholme's qualitative system dynamics method to identify causal relationships and feedback loops among internal and external system variables for attaining health system sustainability in BC. Steps of the qualitative research methodology will be discussed in detail in Chapter Three. The use of qualitative system dynamics diagrams such as causal loop diagrams and their translation into simulation models can assist policy analysis and provide useful insights for the design of performance measurement systems (Santos et al., 2002). For that reason, the causal loop diagram will be used in the next chapter to describe the current system and establish a conceptual performance measurement framework for the BC health system.

Application

As a computer-aided methodology to support policy analysis and design (System Dynamics Society, 2014), system dynamics can be applied to problem solving in many fields such as business, finance, education, transportation, and health. In health system management, published literature in system dynamics applications covers a wide range of topics including

quality improvement (Lane et al., 2000), surge capacity planning (Lubyansky, 2005), resource management (Faezipour and Ferreira, 2013; Lattimer et al., 2003), strategic planning (Cooke et al., 2007), decision support (Marshall et al., 2010), and performance measurement (Parisi, 2010; Santos et al., 2001).

A system dynamics modeling approach can help analysts and managers understand and deal with the dynamic behaviours of complex systems such as health systems (Brailsford, 2007). Systems thinking and system dynamics can be applied to address health system sustainability challenges (Faezipour and Ferreira, 2013). In a qualitative study using system dynamics, constructing causal loop diagrams is usually the main method to graphically represent a system's variables and their interrelationships. Faezipour and Ferreira (2013) have studied health system sustainability extensively and point out that patient satisfaction is a key sustainability indicator and a health system outcome measure. When applying the three pillars of sustainability to study health system behaviours, patient satisfaction is affected by economic, social, and environmental variables. Figure 36 is a causal loop diagram published by Faezipour and Ferreira (2013) showing the "level of patient satisfaction" variable, as a dependent variable, is impacted by accessibility to health services and resources, patients' overall wellbeing, and the cost of health care. At the same time, as an independent variable, patient satisfaction affects patient loyalty and the frequency of patient complaints. This model is helpful to this research. Although not every variable has been taken out from Figure 36 to benefit this research, the structure and layout of this model are the inspirations of the proposed performance measurement model, which will be discussed in Chapter Four.

Another area of criticism against system dynamics is SD's objective view of the complex world (Flood & Jackson, 1991). Social systems are shaped by people's intentions and actions. When analysts examine a social systems issue, it is best to understand subjective interpretations of the issue from members of the social system. Subjective information contains personal opinions, assumptions, interpretations and beliefs. Examining issues subjectively may offer clarification on social system structure and causal relationships between system variables. The system dynamics approach leads analysts to examine issues objectively. For example, one of the solutions to resolve the traffic congestion problem would be to build more roads. Objectively and factually, building more roads makes perfect sense to solve the traffic congestion problem. However, building more roads will harm the environment and pollute the atmosphere during the process of cutting down trees and making asphalt. If the problem is studied subjectively, then one can see providing incentives and convenience for people to drive cars less than they do now might be a better solution. The traffic congestion example shows how studying a problem area objectively can guide analysts to be overly reliant on external facts, ignore internal subjective interpretations of the problem, and lead to ineffective solutions. A solution that is not aiming at the internal causal factors of the problem will introduce unintended consequences. As a performance-based funding model in health care, pay for performance is one of those solutions that potentially could generate unintended consequences (Eijkenaar et al., 2013). To eliminate unwanted results, managers should target the root cause of the problem subjectively using survey-based questionnaires to collect people's opinions and feedback (Flood & Jackson, 1991; Jackson, 2000).

Compared to other systems approaches in Type A – improving goal seeking and viability, system dynamics employs a broader range of systems concepts and offers better prospects for

dealing with system complexity (Jackson, 2003). System dynamics is a true Type A systems approach. It improves the goal seeking capability of a system and ensures system viability. On the other hand, the system dynamics approach does not take enough consideration of other types of systems approaches – exploring purposes, ensuring fairness, and promoting diversity – when finding solutions to large, complicated organizational problems (Jackson, 2003).

In the system dynamics approach, system structure is considered as the determining force behind system behaviour. The relationship between feedback loops are identified and linked to map the system structure. The aim is to better manage behaviours by targeting the system structure and the causal relationships within it. System dynamics offers value to managers in dealing with large organizations and solving complex organizational problems. The ongoing research and development of the SD approach will continue with its strength in looking past the surface of the problem and study underlying patterns of feedback loops. Shortcomings of SD should be considered during both qualitative and quantitative analysis processes. A critical systems thinker likely will combine the strengths of system dynamics with what other systems approaches have learned to do better (Jackson, 2003).

2.4 Qualitative System Dynamics for Performance Measurement of Sustainability

Parisi (2010) proposed that the adoption of qualitative system dynamics frameworks may improve second generation performance measurement models that are designed for supporting social and environmental dimensions of business performance. Non-financial performance measures including stakeholder satisfaction and community relations have become important for monitoring organizational performance, and they can provide companies with competitive advantages when considered in combination with financial indicators (Townley et al., 2003).

The systems theory literature points out that mental models are conceptual interpretations of the system (Forrester, 1961; Sterman, 2000; Wolstenholme, 1990). Mental models can be used to describe the system structure and further explain system behaviours. The second generation performance measurement frameworks are consistent with the systems approach to business management and performance measurement because they rely on the linkages identified in mental models to select performance measures for controlling system behaviours (Parisi, 2010). Many performance measurement frameworks have not been successful due to cognitive limitations and managerial bias in constructing mental models. Therefore, the accuracy of mental models or system descriptions is extremely critical to the success of subsequent steps in the performance measurement process. The qualitative system dynamics method can help in overcoming limitations of mental model development by identifying cause and effect relationships as well as feedback mechanisms that drive system improvements.

Parisi (2010) encouraged organizations to conduct workshops and group meetings so that individual mental models or causal loop diagrams can be integrated into a corporate causal map. The combination of causal diagrams can validate and consolidate all participants' interpretations of complex problems and their potential causes, hidden feedback loops between performance measures and system factors, as well as policy levers for change. Specifically, a two-stage system dynamics approach was recommended to address social and environmental performance measurement such as sustainability resource issues. The first stage focuses on the development of a qualitative causal map from collected perceived interrelationships amongst organizational elements. This causal map should be aligned with and have a positive influence in the implementation of system or corporate strategy. The second stage involves the simulation of the causal map by converting organizational elements into stock and flow variables, inputting

applicable data, and explaining simulation results to identify the best strategy for the organization. Without an accurate causal map from the qualitative analysis stage, results from the second stage, quantitative analysis, become meaningless. In her words, Parisi (2010, p. 121) stated that “given the peculiar characteristics of sustainability resources a qualitative [system dynamics] approach is preferable in order to elicit key performance indicators and assign targets to improve the performance measurement systems.” This statement and the movement of adopting system dynamics methodology in performance measurement of sustainability are inspirations for this research.

2.5 Summary

Chapter Two provides a literature review on three important topics for this research: health system sustainability, system performance measurement, and system dynamics. From the Brundtland Report (Brundtland, 1987) to the three pillars of sustainability (Adams, 2006), from the Sustainable Health Systems Project (World Economic Forum, 2013) to the Health and Health Care Sustainability Framework (Prada et al., 2014), the researcher learned from international experiences that as system resources become limited, endeavours to maintain system sustainability require a holistic view to be taken. The traditional reductionist method of dissecting a complex system into pieces for analysis can no longer lead to effective solutions. The theory and practice of applying a systemic perspective to system improvement have influenced the design of performance measurement systems. From the Performance Measurement Matrix (Keegan et al., 1989) to the Balanced Scorecard (Kaplan and Norton, 1992), from the Strategy Map (Kaplan and Norton, 2000) to the Value Creation Map (Marr et al., 2004; Neely et al., 2002), it is indicated that modern frameworks take greater consideration of external and environmental factors that impact system operations.

Many frameworks and systems are reviewed in this chapter. Among them the Conference Board of Canada Sustainable Health and Health Care Framework and the CIHI Health System Performance Measurement Framework stand out in providing the most learning opportunities. Both frameworks have been compared with international examples and have shown the most comprehensive coverage in either sustainability framework elements or performance measurement components. Table 10 shows the matching of common variables between the sustainability and performance measurement frameworks to help construct the desired performance measurement model for supporting a sustainable health system in BC. Some variables are bundled together when a similar meaning can be established between variables. Table 10 demonstrates all 10 sustainability framework elements from the Conference Board of Canada can be matched with 12 components of the CIHI performance measurement framework. Three out of the 15 components from the CIHI framework have no match identified.

The Conference Board of Canada Health and Health Care Sustainability Framework Elements	CIHI Health System Performance Measurement Framework Categories
Effective disease prevention and health promotion	2.4 Adjustment to population health needs 4.1 Improve health status of Canadians
Accountability for results	4.2 Improve health system responsiveness
Value for money Funding models that drive desired behavioural change	4.3 Improve value for money
Effective health and health care systems Appropriateness	3.4 Appropriate and effective
Leveraging innovation and innovative technologies	2.5 Health system innovation and learning capacity
Fair and timely access	3.1 Access to comprehensive, high-quality health services
Optimal development, alignment, and support of human resources	2.2 Health system resources 2.3 Efficient allocation of resources 3.5 Efficiently delivered
Strategic alignment with determinants of health	1.1 Structural factors influencing health 1.2 Biological, material, psychological and behavioural factors
	2.1 Leadership and governance
	3.2 Person-centred
	3.3 Safe

Table 10: Common Variables between Sustainability and Performance Measurement Frameworks

The review and comparison of different models, systems, and frameworks in this chapter provide the basis to establish a conceptual framework for developing the performance measurement model to address health system sustainability issues. Figure 37 illustrates a conceptual framework developed from knowledge gained through literature review on the three main topics for this research. The following list summarizes lessons learned to construct the conceptual framework for this research:

- Lessons learned from top performing sustainable health systems among the OECD countries and the Conference Board of Canada Sustainable Health and Health Care Framework highlight that when examining health system sustainability, the focus needs not only to be on performance within the health system, but also to include external variables that are impacting the operations of the health system. Consequently, the conceptual framework (see Figure 37) indicates different care sectors and services within the health system being measured. As the health system supplies care and services to the population, the environment in which the population resides has impacts on the demand on the health system. This demand is important and should not be ignored when the sustainability of the health system is threatened. The consideration of external influences is also observed in the performance measurement literature.
- The performance measurement literature points out that an effective performance measurement system is able to consider changes in the internal and external environments of an organization (Neely et al., 2000; Purbey et al., 2006). Some of the second generation performance measurement systems, e.g., The Strategy Map (Kaplan and Norton, 2000), the Value Creation Map (Marr et al., 2004), and the CIHI performance measurement framework (CIHI, 2013b), showed the acknowledgement of external

influence. To examine health system sustainability issues in BC, the performance measurement system in the conceptual framework (see Figure 37) should measure variables both internal and external to the health system.

- The review of BC's current performance measurement practices, particularly in the BC Health System Strategy (see Figure 32 on Page 74) and the BC Health Quality Matrix (see Figure 33 on Page 76), identifies five performance dimensions as essential to measure health system performance from both an individual and a population perspective. The inclusion of these five dimensions is also supported by Canadian frameworks. The Alberta Health System Outcomes and Measurement Framework (see Figure 26 on Page 60) has the same five performance dimensions plus the efficiency dimension to measure the quality of health services delivery. The CIHI Health System Performance Measurement Framework (see Figure 22 on Page 49) also includes these five dimensions in the Health Systems Outputs quadrant to ensure high-quality system outputs impacting system outcomes and social determinants of health. Therefore, following the Canadian examples and building on what BC is already working on, the conceptual framework for the proposed health system performance measurement model should include the same five performance dimensions: accessibility, safety, appropriateness, effectiveness, and acceptability.
- The selection of performance measures and the collection of available data are iterative on a monthly, quarterly, or annual basis. As indicated in the Alberta framework, performance measures can be categorized under different cascades of accountabilities for different purposes and audiences. This process is reflected in the conceptual framework to present the ongoing adjustment and development of a performance measurement

model so that it does not become static or outdated. It is worthwhile to note that although performance measures are mentioned in this chapter, they are for discussion purposes only. This research does not recommend a specific list of performance measures for the BC health system to adopt. Performance measures are often selected based on the chosen performance dimension, which can vary depending on the strategic goals and objectives of the system. This research calls attention to the interrelationships among performance variables (either measures or dimensions) internal to the system and their interactions with external variables. The causal feedback loops formed by internal and external system variables are the focus of this research.

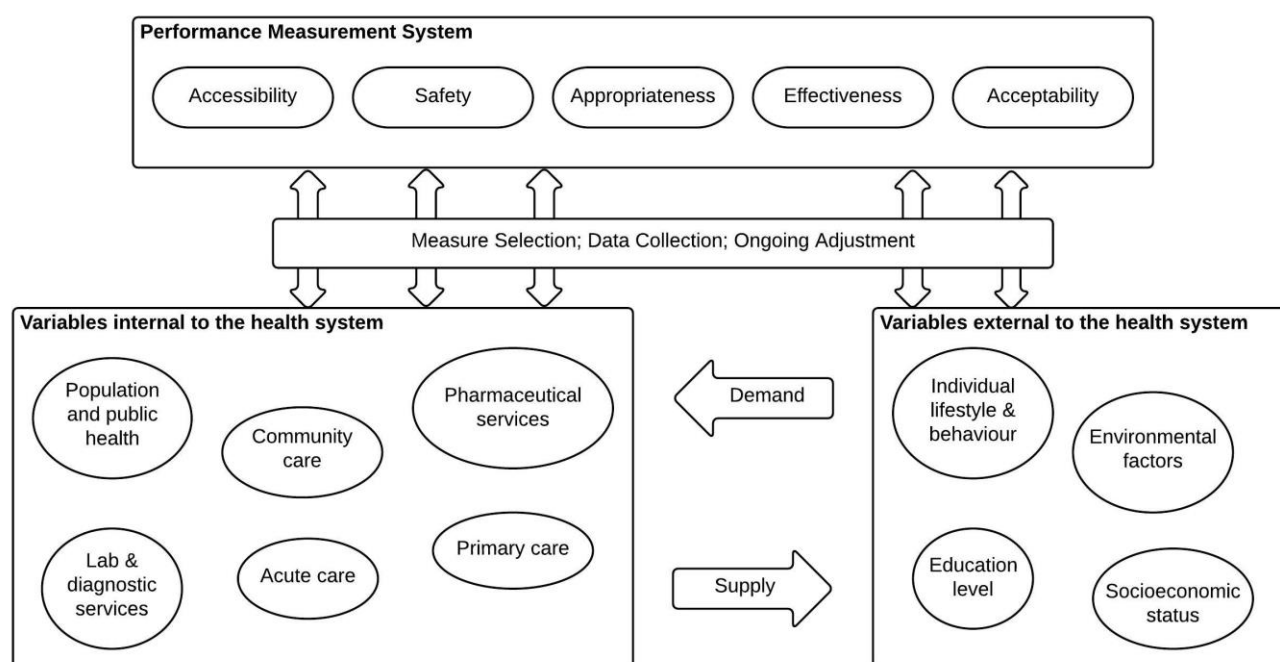


Figure 37: A Conceptual Framework for a Performance Measurement Model on Health System Sustainability

After the review of systems theory literature and an examination of the history and application of system dynamics as a research method, qualitative system dynamics proves to be a well-suited method to the purpose of this research. A sample qualitative system dynamics causal

loop diagram is also reviewed to demonstrate its application in addressing health system sustainability issues and justify the selection of this research method for this study.

Literature on topics of health system sustainability, system performance measurement, and system dynamics establishes the basis for this research to develop a system dynamics-based performance measurement model for a sustainable BC health system. Chapter Three will briefly outline the systematic research methodology this research follows to produce the final product.

Chapter 3 Research Methodology

This chapter describes the methodology used for this research. Research methodology is a sequence of steps to respond systematically to the research question (McGregor and Murnane, 2010). The methodology used in this research is qualitative in nature because it aims to understand different perspectives on research topics from the literature and the interview participants. Research methods are tools and techniques, and they are often components of a research methodology (McGregor and Murnane, 2010).

A descriptive research methodology was applied for this study. Below is the sequence of 10 steps to answer systematically the three research questions¹⁰ identified on Page 11 of this thesis:

1. **Define problem area:** Numerous statistics indicate that the BC health system is unsustainable if health spending continues to increase as it has been over the past decade. The three research questions address the unsustainable health system in BC.
2. **Review literature:** This research reviews a body of literature to seek potential solutions or best practices which address the research questions. The literature review provides insights on the three main research topics: health system sustainability, system performance measurement, and system dynamics. The three search tools used are: the University of Victoria (UVic) online libraries search engine, the BC Ministry of Health library search engine, and the Google Scholar. Results from these search engines cover

-
1. What are the structural-level variables and their interrelationships of the BC health system that impact sustainability?
 2. What is the explanation behind these interrelationships among system variables and how can policy levers be identified to achieve health system sustainability?
 3. How can the proposed model assist in BC's performance measurement practices for a sustainable health system?

all academic databases such as EBSCO, PubMed, and IEEE Xplore. The keywords used in the search were “sustainability”, “system sustainability”, “health system sustainability”, “performance measurement system”, “performance measures”, “health system performance measurement”, “systems approach”, “systems theory”, “system dynamics”, and “qualitative system dynamics.” These terms were used in combination.

3. **Select research methods:** After reviewing the literature, it becomes clear to the researcher that the design of a performance measurement system, which would address sustainability issues within a health system, can benefit from the qualitative system dynamics (QSD) approach. Therefore, QSD is used as the main research method to improve the current performance measurement practices in BC. As well, in-depth interviews were conducted at the BC Ministry of Health to validate the model. The model is developed based on the information delineated from the literature review.
4. **Describe the current state:** Following the first phase of QSD, the researcher examines the current context and describes the BC performance measurement system using a diagram called *The Tree of Measures*.
5. **Model the future state:** The researcher applies the knowledge generated from the literature review to create a system dynamics-based model called *The Web of Measures*. Creating a model comprises the second part within the first phase of the QSD research method.
6. **Apply for human research ethics approval:** After the *Web of Measures* model was developed, the research applied to the University of Victoria for human ethics research approval and prepares to conduct interviews. Tasks at this step involve working with

thesis supervisor to finalize the human research ethics application and participant consent form, develop interview questions, and draft a recruitment advertisement script. The human research ethics application package also includes the thesis proposal, which the researcher works with the thesis committee on an iterative process in order to establish agreement on research purpose, scope, and direction.

7. **Recruit interview participants:** After obtaining the human research ethics approval, the researcher works with the Internal Communications and Engagement Team at the BC Ministry of Health to advertise this research and recruit interview participants. The recruitment and selection of interview participants are done by the Internal Communications and Engagement Team. All processes during this step comply with the research standards and requirements set by the UVic Human Research Ethics Board.
8. **Conduct model validation interviews:** Fifteen participants are interviewed based on the 10 selected interview questions. Each interview is one hour long comprised of a 15-minute presentation for background information and to familiarize participants with the model, a 30-minute questions and answers period, and a 15-minute discussion.
9. **Analyze interview data:** Comments and feedback from all 15 participants were inserted under each interview question (see [Appendix L](#)). This helps to generate improvement themes for enhancing the pre-validation model.
10. **Update the pre-validation model:** Relevant participant comments for improving and developing the model are highlighted and incorporated in the post-validation model. The post-validation model is developed from the pre-validation model and is a central part of this research.

Chapter Three discusses the research methodology used in this research. From defining the problem area to reviewing bodies of literature, from describing the current state to modeling the future state, from recruiting interview participants to analyzing interview data, a sequence of 10 steps are described in this chapter to answer the research questions. Methods used for this research are discussed in detail in the next chapter.

Chapter 4 Methods and Findings

This chapter provides a detailed description of how the two-phase qualitative system dynamics was used as the main research method to construct a system dynamics-based performance measurement model for the BC health system. Step 4 to 10 in the research methodology outlined in the previous chapter will be presented in detail here. As the product of this research, a post-validation model will be interpreted.

4.1 First Phase: Model Creation

Although there is no clear separation between qualitative and quantitative system dynamics, qualitative system dynamics is applied to represent system dynamics without specific quantification of variables and computer simulation analysis (Wolstenholme, 1985). QSD focuses on creating cause and effect diagrams, also known as causal loop or influence diagrams, to explore and analyze the system. These diagrams put emphasis on identifying feedback perspectives of the system and are often developed with the current knowledge of the system structure, information flows, and strategies. QSD diagrams can be used to explore qualitatively alternative structure and strategies from within and outside of the system. This research relies on the underlying premise of system dynamics that “the feedback structure of a system is a direct determinant of its behaviour over time” (Wolstenholme, 1990).

As the qualitative system dynamics is the primary method for this research, the two phases of QSD – problem exploration/model creation (phase one) and model analysis (phase two) – are adapted with minor changes in the sequential procedure. [Appendix I](#) shows the nine steps in phase one of QSD published by Wolstenholme (1990). The nine steps are grouped into three steps: 1) explore the current situation; 2) identify key variables, organizational boundary,

and construct linkages between variables; and 3) create the causal model. This section of the chapter describes how the three steps are applied.

4.1.1 Current State – Tree of Measures

Step 1 to 3 in the first phase of qualitative system dynamics pertain to recognizing key variables associated with the perceived cause for concern. Only steps associated with the qualitative analysis will be used for this research. Other processes such as obtaining data for variables and identifying initial levels, which are more relevant for the subsequent quantitative analysis, are considered out of scope for this research; therefore, they have been excluded. Identified variables should be closely related to the problem being examined. For this research, variables for building a performance measurement system to achieve health system sustainability will be chosen.

The literature points out that the health system sustainability issue is well-recognized across the province. The newly-published BC Health System Strategy outlines a provincial strategic plan to obtain the Ministry's vision of "achieving a sustainable health system that supports people to stay healthy and provides high quality publicly funded health care services that meet their needs when they are sick" (BC Ministry of Health, 2014b). The BC Patient Safety and Quality Council's Health Quality Matrix recommends the consideration of the seven dimensions of quality and four areas of care¹¹ can lead to sustainable access and delivery of health care services (BCPSQC, 2012). The BC Health System Strategy (BC Ministry of Health, 2014b, p. 12) states that to achieve health system sustainability in the next three years, the province will focus on the five dimensions of quality outlined by the BC Patient Safety and

¹¹ Seven dimensions of quality: accessibility, safety, appropriateness, effectiveness, acceptability, equity, and efficiency. Four areas of care: staying healthy, getting better, living with illness or disability, and coping with end of life.

Quality Council to deliver quality health services and provide patient-centred care. As previously stated, the five dimensions of quality are:

1. Accessibility: ease with which health services are obtained.
2. Safety: avoiding harm resulting from care.
3. Appropriateness: care that is provided is evidence-based and specific to individual clinical needs.
4. Effectiveness: care that is known to achieve intended outcomes.
5. Acceptability: care that is respectful to patient and family preferences, needs, and values (see Figure 34 on Page 77).

To further confirm the validity of these five dimensions focused on by BC, other Canadian jurisdictions' performance measurement frameworks, which also have an emphasis on health system sustainability, cover the same five dimensions (see Table 10 on Page 94). The Conference Board of Canada's Health and Health Care Sustainability Framework chooses Accessibility and Appropriateness as two of its four guiding principles, and Effectiveness and Acceptability are included as two of the six key factors. CIHI's Health System Performance Measurement Framework provides detailed analysis of these five performance dimensions in the Health System Output quadrant. AHS' Health System Outcomes and Measurement Framework also contains the five dimensions within its Health Services Delivery performance domain (see Figure 27 on Page 62). This inclusion of the five dimensions of quality in other Canadian performance measurement systems leads the researcher to select these five performance dimensions to form the structure for the BC performance measurement system.

A review of Canadian national performance measures in CIHI's Indicator Library (see [Appendix C](#)) shows how performance measures are categorized based on different dimensions. High-level categories of performance measures can be formed to group measures under the

chosen five performance dimensions. The BC Ministry of Health's annual Service Plans indicate performance measures are currently assigned based on strategic goals and objectives.

Consequently, the current state of performance measures can be interpreted in a diagram called *Tree of Measures* (see Figure 38).

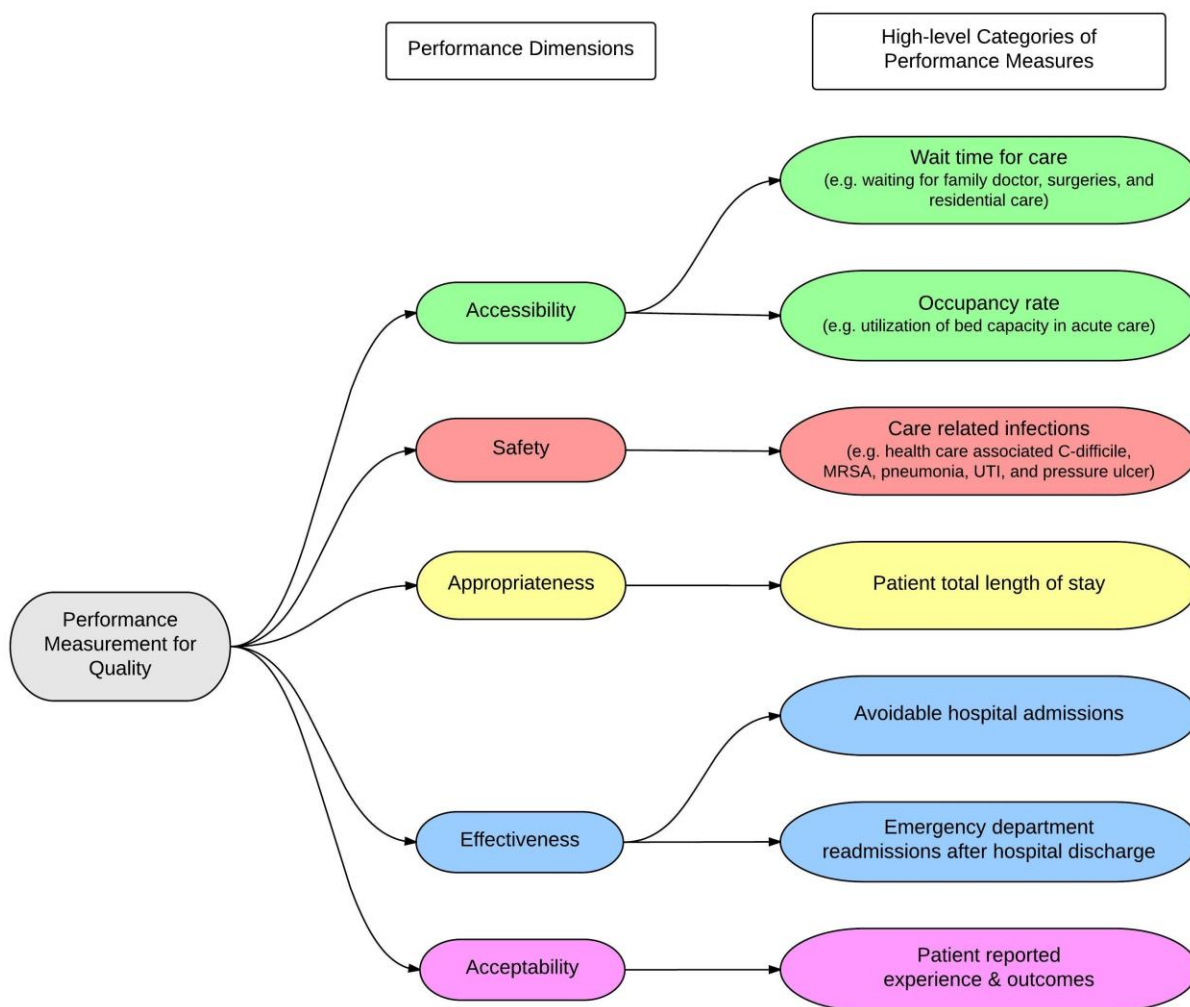


Figure 38: The Current State of Performance Measurement in BC - Tree of Measures

The *Tree of Measures* diagram can be interpreted as follows:

- Performance measures under the Accessibility dimension can be categorized into two groups: wait time for care and occupancy rate. This is reflected in the CIHI Indicators

Library as wait time measures are grouped under the performance dimension 3.1 – access to comprehensive, high-quality health services. Similar groupings of performance measures under specific performance dimensions can be seen in [Appendix C](#). The wait time for care category includes waiting for a family doctor, surgeries, or a residential care bed. The occupancy rate category contains measures regarding utilization of bed capacity in acute care.

- The safety dimension contains measures on health care associated infections such as C-difficile and Methicillin-Resistant Staphylococcus Aureus (MRSA). CIHI uses the term “Nursing Sensitive Adverse Events” to include pneumonia, urinary tract infections, and pressure ulcers. These measures are grouped into the care related infections category.
- Appropriateness and effectiveness dimensions are closely linked with each other. CIHI groups the two performance dimensions together and often refers to the measures as addressing both appropriateness and effectiveness issues. Currently in BC, measures related to patient total length of stay in different care settings are considered appropriateness measures. Avoidable hospital admissions, also known as “Ambulatory Care Sensitive Conditions” according to CIHI, and emergency department (ED) readmissions after hospital discharge are considered effectiveness measures.
- The acceptability dimension examines whether health services are acceptable to patients and health consumers. Measures in this dimension focus on patient reported experience measures (PREMs) and outcome measures (PROMs).

As shown in Figure 40, the current state of performance measurement has its strengths and weaknesses. The tree structure shows a clear categorization of measures into performance dimensions. This organization of measures allows health system managers and analysts to easily

identify performance measures for specific purposes or goals. Nevertheless, the tree structure creates silos in performance management. The weakness of this approach lies in reliance on individual spotlights on performance while the interrelationships among variables are ignored. As Neely et al. (2003) point out, an advantage of the second generation performance measurement systems when compared to the first generation is the ability to realize the dynamics of value creation, link system variables together across performance dimensions, and visualize the linkage between different variables.

4.1.2 Cause and Effect Relationships

Step 4 to 7 in the first phase of QSD are concerned with constructing cause and effect flows between variables and identifying organizational boundaries. This research builds on the identified variables – the five performance dimensions and their high-level categories of measures – and seek cause and effect relationships between these variables. Before constructing these flows, it is worthwhile to review a set of notations used in the causal diagrams for this research. There are variations of notations used to present causal relationships. In this research, the following notation is preferred:

- **Directions:** the direction of the arrow indicates the direction of causality for a pair of variables. The variable at the tail of the arrow is the independent variable, or the cause, and the variable at the head is the dependent variable, or the effect.
- **Associations:** a plus (+) sign shows the positive association between variables, and a minus (-) sign shows the negative association. A positive association means an increase in the independent variable leads to an increase in the dependent variable; the change is in the same direction. A negative association means an increase in the independent

variable causes a decrease in the dependent variable; the change is in the opposite direction (McDonnell et al., 2013, p. 1284).

- **Polarities:** a causal loop can be called either reinforcing or balancing. In a reinforcing loop (R), the feedback effect reinforces the original change, and the loop contains an even number of negative causal links. Reinforcing feedback loops can lead to extremely rapid changes in systems. In a balancing loop (B), the feedback effect opposes the original change, and it contains an odd number of negative causal links. Balancing feedback loops tend to be more self-regulating in systems (Sterman, 2000, p. 142).
- **Delay:** a delay is a lag between cause and effect, or independent and dependent variables. Such lag in systems can cause instability and oscillation (Kirkwood 1998), and it is displayed by a vertical equal sign (||).

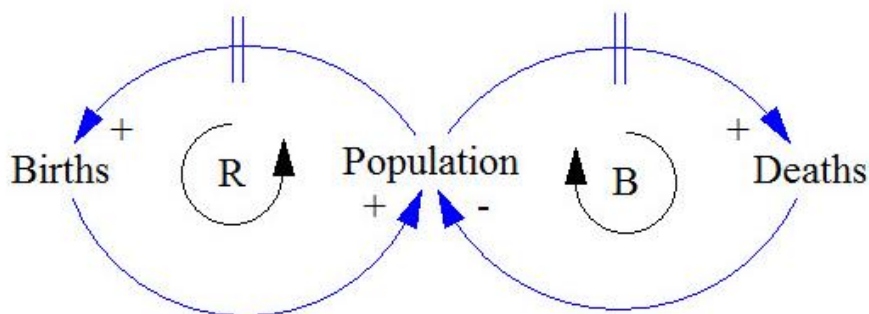


Figure 39: Population Causal Loop Diagram (Zhou, 2012)

Figure 39 is a population causal loop diagram. It is an appropriate example because it includes each of the notations mentioned above. Some of the notations will be used for the diagrams in this research.

Figure 40 illustrates the identified variables in the *Tree of Measures* diagram (see Figure 38) are rearranged and causal relationships are established to link these variables. The same colour scheme used in the *Tree of Measures* diagram is used in Figure 40. Some of these causal

links are based on the literature, and some are quite straightforward. It is important to note that the references used in Figure 40 are only samples to prove the establishment of linkages. There are many other studies that can also support these causalities. Figure 40 can be interpreted as follows:

- All of the variables are put within the health system boundary as they can be controlled and managed by the people within the health system.
- The effectiveness of health services influences many other performance dimensions including accessibility, appropriateness, and safety. For example, an increase in the number of avoidable hospital admissions affects the occupancy rate within the acute care environment (up to the point of maximum occupancy). When the number of emergency department readmissions after hospital discharge increases, the level of three other variables may also increase because those patients may be sicker than they were in the original admission: patient total length of stay, wait time for hospital care (CIHI, 2012), and care-related infections (CIHI, 2012).
- A higher hospital occupancy rate may be one of the elements responsible for higher patient total length of stay. Research conducted in the US, for example, points to a positive correlation between occupancy rates and patient length of stay (Wiler et al., 2012). Hence, as the occupancy rate increases, patient total length of stay also increases. Reducing patient length of stay in hospitals can lead to shorter average wait times for care (Santos et al., 2002). Therefore, the association between the two variables is positive.
- Finally, it is shown in the *Tree of Measures* diagram that the Acceptability dimension is the end-result that all other performance variables are trying to impact. One of the aims

of the health system is to provide health care services that are acceptable to patients and health consumers, i.e., that meet their needs related to their health. Greater availability of health resources will likely lead to a shorter wait time for care and are associated with higher patient satisfaction and experience with the health system (Bacon and Mark, 2009). The reverse is also true. For example, a rise in wait time for care would likely lead to a worsening in ratings of patient reported experience and health outcomes. Another performance dimension impacting patient satisfaction is the Safety dimension. A study conducted by Carlson and Gabriel (2001) examining relationships among patient satisfaction, effectiveness of substance abuse treatment services, and patient health outcomes indicated that more effective health services lead to fewer incidents of care-related injuries (e.g., infections, abuse of medications, falls, etc.); therefore, to better patient reported satisfaction and outcomes. Both evidence-informed links and impacts to “Patient reported experience & outcomes” are reflected in Figure 40.

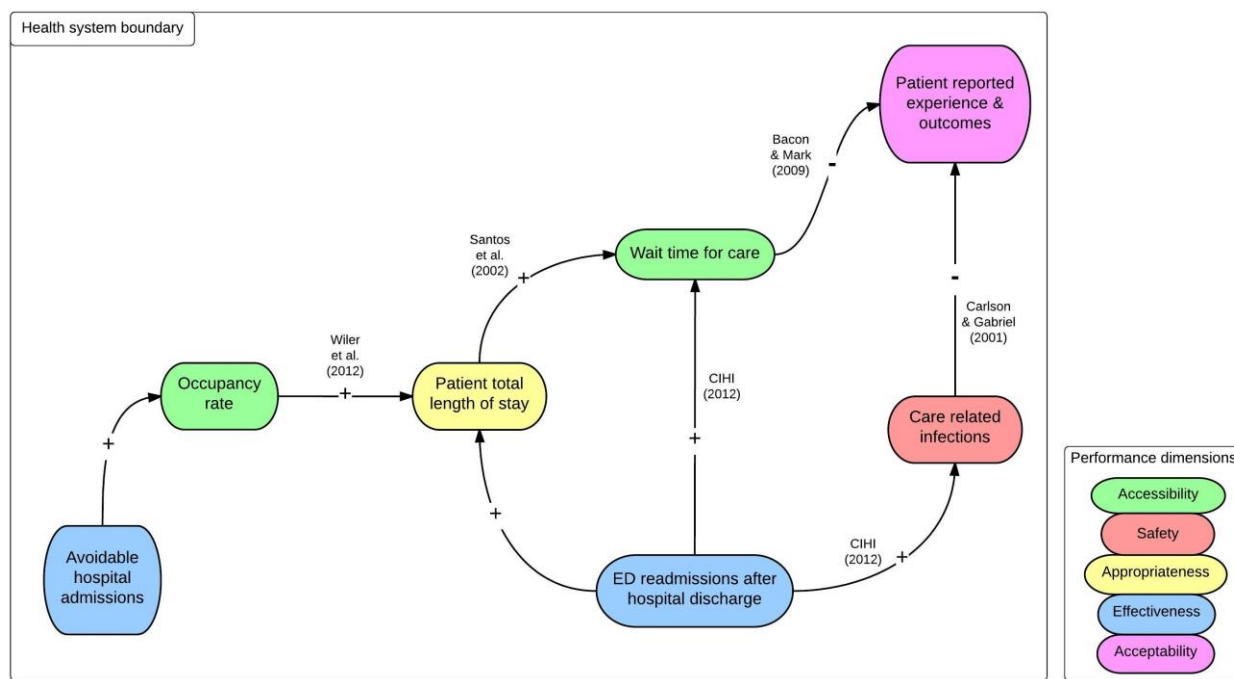


Figure 40: Causal Relationships between Performance Measures

The interrelationships between variables within a health system are not difficult to recognize. As a research method, the QSD can help in identifying and linking health system variables. Figure 40 is an attempt to connect health system variables in a meaningful way with an emphasis on acute (hospital) care measures. Although Figure 40 is a simplification of very complex drivers of hospital performance, it advances the *Tree of Measures* diagram by demonstrating the dynamics embedded within the system structure. The next section explains how the last two steps in the first phase of QSD are used to expand Figure 40.

4.1.3 Future State – Web of Measures

Step 8 of the first phase of QSD refers to identifying any new variables. Since the aim of this research is to produce a conceptual performance measurement model for supporting health system sustainability and numerous bodies of literature have pointed out that a holistic view of performance management is needed, one can recognize that more variables than those included in the *Tree of Measures* should be incorporated. Step 9, the last step of QSD's first phase, indicates a reiteration of step 1 to 8 should take place if necessary. The researcher went back to the literature, revisited some of the contents on sustainability and performance measurement systems, and selected more variables both internal and external to the BC health system. Internally, variables such as use of health services, care capacity, and patient discharge rate are added. These variables are essential in describing the main story, which will be elaborated further in the next phase of QSD. Externally, the population variables (see Figure 39) described earlier are included along with six other variables that are exogenous to the health system. External variables influence the demand on the health system. They also have a major impact on the operations of the health system; therefore, it is imperative to take these variables into consideration when planning to tackle health system sustainability issues.

It is important to reiterate here that this paper focuses on the interrelationships among performance variables to enhance performance measurement. It is not about which performance measures BC should adopt. The chosen measures in this paper are from the CIHI Indicator Library and are used as proxy measures to support performance dimensions. In the real world, measures are chosen for various reasons (e.g. strategic objectives, competing interests, financial incentives, etc.). This thesis emphasizes on the shift of linking performance measures via cause and effect relationships and suggests health system managers to move away from performance measurement in isolation.

It was an iterative process requiring multiple attempts to develop Figure 43, the future and recommended state of a performance measurement model for a sustainable health system in BC. Since this is an enhancement from the *Tree of Measures* diagram and variables are linked, Figure 41 is named, *Web of Measures*. The next section of this chapter focuses on the second phase of QSD, model analysis, and will examine the *Web of Measures* diagram in a greater detail.

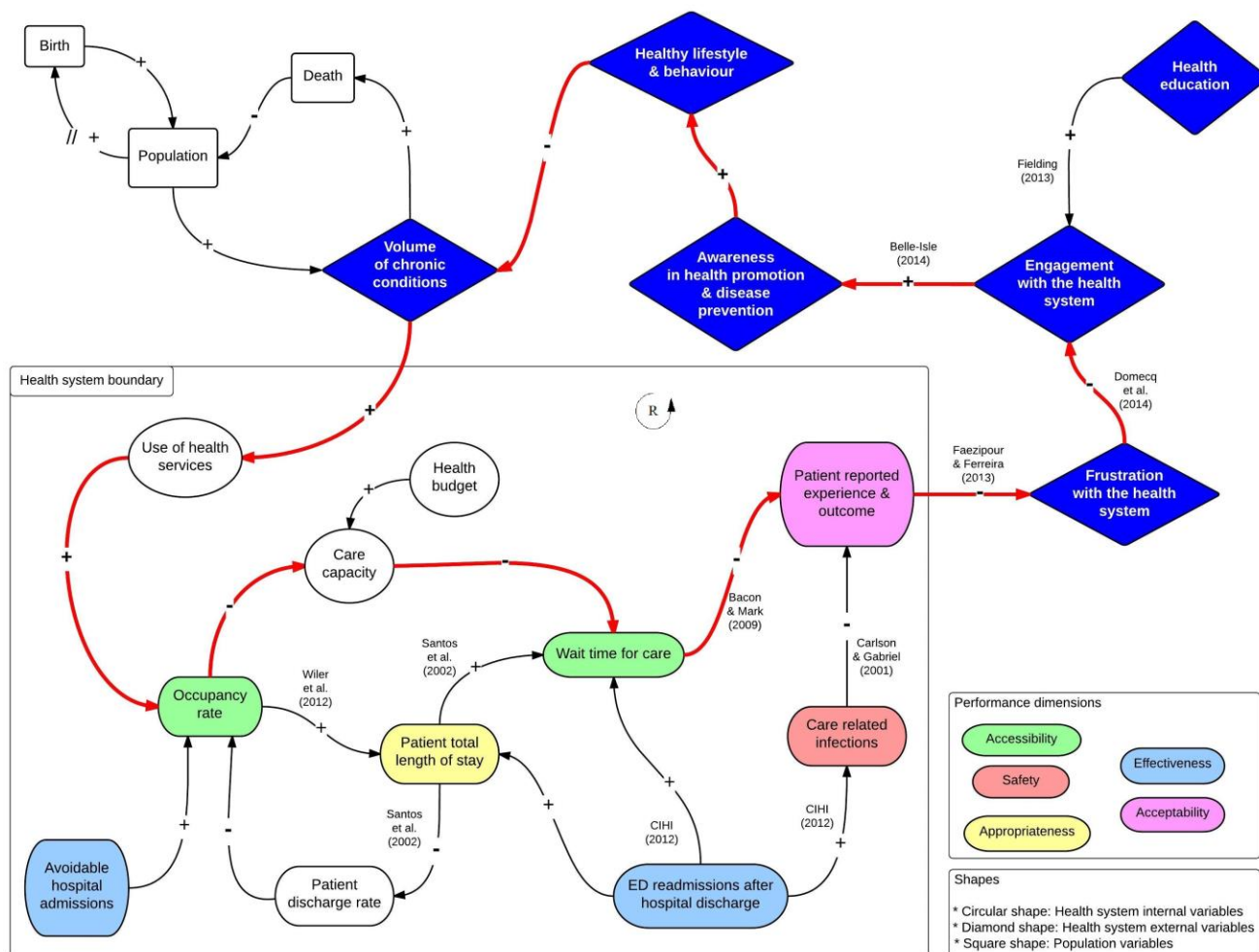


Figure 41: The Future State of Performance Measurement in BC - *Web of Measures*

4.2 Second Phase: Model Analysis

There are six steps in the second phase of QSD ([see Appendix I](#)). This section explains how the six steps are adapted to this research and used to analyze the model, also known as the *Web of Measures* diagram. In Figure 41, model legends are shown at the bottom, right side corner. The five performance dimensions from the *Tree of Measures* diagram are used with the same colour scheme. Circular shapes are used for variables that are within the health system boundary. These are considered internal health system variables because they can be controlled by the people who work in the health system. Diamond shapes are used to represent variables

that are external to the health system. Although the external variables cannot be controlled by the health system, they are included in the model because they have major impacts on the operations of the health system. Square shapes are used to show population variables as they relate to the clients the health system serves.

4.2.1 Major Feedback Loop

Step 1 of the QSD second phase requires the major feedback loop in the model to be isolated. At this step, the research identifies the main loop within the *Web of Measures* diagram. In Figure 41, the loop highlighted in red is the major loop. It is also the main story that the model conveys. The main story can be communicated starting from the population variable. As the population in the province grows, the volume of chronic conditions increases. The higher the volume of chronic conditions, the higher the use of health services, which would then lead to a higher level of occupancy in health care facilities. As more people using the health services and occupying beds, the overall care capacity of the health system goes down. When care capacity reduces, patients may experience an increase in wait times for care. If patients wait longer for care services, then they may be more likely to report poor experiences with the health system and may also have an adverse health outcome as a result of having to wait for care. As patient satisfaction level falls, patients tend to be frustrated and complain about the system (Faezipour and Ferreira, 2013). On average when patients are frustrated with the health system, they are likely to be disengaged with the publicly-funded health system and look elsewhere, e.g., medical tourism or private health care, for faster or better services (Domecq et al, 2014). Such disengagement may lead to a lack of patient participation in beneficial activities that contribute to health promotion and consequently, overall higher levels of unhealthy lifestyles and behaviours (Belle-Isle, 2014). A greater volume of chronic conditions such as diabetes,

hypertension, heart diseases, and obesity would appear. This goes back to where the loop had started to increase the use of health services.

4.2.2 Loop Polarity

Step 2 in the second phase refers to determining the polarity of the feedback loop and comparing the model message to reality to test the validity of the model. As feedback loops control the behaviour of a system over time, it is critical to understand which type of polarity the main loop in the *Web of Measures* model demonstrates. Indicated by the R in the middle of the highlighted loop, the main loop is a reinforcing feedback loop. From a technical standpoint, it has six negative causal links. The notations described in Section 4.1.2 indicate a causal loop is reinforcing when there is an even number of negative causal links. Reinforcing feedback loops can cause exponential growth or decline. It is not sustainable, which aligns with the current problem the BC health system is facing.

The message exhibited from this reinforcing feedback loop is consistent with the reality. As more patients enter the health system seeking health services, the system guides patients through the care pathway. However, as the care capacity is limited and the operations of the health system can be challenging at times, patients often end up leaving the system frustrated. Frustrations with the health system may lead to patients becoming disengaged and consequently, unawareness of healthy choices and behaviours. This may lead to an increasing incidence and prevalence of chronic conditions in the population. The reinforcing feedback loop confirms what health policy makers are seeing in the province: a treatment-reliant health system is no longer capable of addressing the higher-than-ever patient demands from a chronic conditions heavy society.

4.2.3 Policy Levers

Step 3 and 4 of the second phase of QSD are about identifying possible ways to control these variables. In the context of this research, health policy levers can be identified to influence the system behaviour generated from the model. As shown in *Web of Measures*, two policy levers are chosen with the potential to change the outcome of the model. One policy lever is internal to the health system, i.e., the health budget, and the other is external to the health system, e.g., health education. These two policy levers are only sample levers to demonstrate the point that they exist both internal and external to the health system. There are many policy levers that have major impacts on the sustainability of the health system.

Statistics shown in this research have demonstrated an upward trend in health spending internationally, nationally, provincially, and regionally. As the health budget increases, more care capacity can be created; therefore, the system is able to treat patients better and faster. This would lead to shorter wait time for care and more satisfied patients. Subsequently, patients become less frustrated, more engaged, aware, and healthier. As the health system consumes more of the provincial budget other services such as education, transportation, and environmental protections are forced to operate with fewer resources. The control is not about how much health budget should be increased, rather how effectively and efficiently the health system can work with the existing budget to generate greater results. Meanwhile, external solutions should also be considered.

A second policy lever of health education is included in the model to highlight the importance of keeping all residents educated about health matters and self-care. Research indicates that keeping residents educated and informed of self-care may lead to a healthier society and, subsequently, may shift demands from acute to preventive care (Belle-Isle, 2014;

Fielding, 2013; Krames, 2010). The health education variable, as an external policy lever in the context of health system sustainability, may have a greater influence than internal policy levers. The intention of increasing health education in the population is to improve patient self-care so as to improve health and reduce the incidence of chronic conditions, thereby reducing demand for downstream health services.

4.2.4 Involving Stakeholders

Step 5 refers to the ongoing assessment of the model behaviour as more data are collected and new feedback loops are created. Step 6 focuses on the reiteration of steps 3-5, if necessary. Considering the purpose and scope of this research, the researcher feels *Web of Measure* as is in Figure 41 is ready to be shown to stakeholders who work in the BC health system for comments and feedback. *The Web of Measure* is built based on knowledge gained from the literature review and also represents the researcher's mental model based on educational background and work experience. As system dynamics practitioners, e.g., Forrester, Wolstenholme, Meadows, Sterman, and Lane, point out, it is crucial to involve stakeholders during the initial stage of model building. While it is important to engage computer technology for simulation during the quantitative phase, interpretations of the real-world activities during the qualitative phase are critical. Wolstenholme insists that stakeholder involvement is valuable in both qualitative and quantitative phases. This may be the most appropriate method to ensure a solution is selected and implemented based on accurate interpretations of the problem (Wolstenholme, 1990).

All mental models are biased and imprecise. It is only when multiple opinions and expertise are combined can a model achieve greater accuracy. In his 12 principles for successful use of system dynamics, Sterman (2000) states that validation is a continuous process of testing

and building confidence in the model. Stakeholder involvement via a set of model validation interviews is the next step and will be described in the next section.

4.3 Model Validation Interview

In order to improve *Web of Measures* and expand its applicability to the BC health system, the researcher conducted model validation interviews. In addition to validating the model, the interviews improve its applicability in the real world.

4.3.1 Human Research Ethics Application

The researcher worked closely with his thesis supervisor and committee members to prepare the Human Research Ethics Application package that consists of the Application Form for Research Ethics Approval for Human Participant Research, the Recruitment Advertisement Script, Interview Questions, the Participant Consent Form, and the approved thesis proposal by the thesis committee. It took three iterations of reviews and updates to finalize the application package. This research was approved by the University of Victoria Human Research Ethics Board on February 11, 2015 and assigned Ethics Protocol Number 14-451 (See [Appendix J](#)).

4.3.2 Recruitment

The recruitment of interview participants started soon after the researcher received the Certificate of Approval. A draft of the recruitment advertisement script was written and shared with the Internal Communications and Engagement (ICE) team at the BC Ministry of Health. To comply with all research standards and requirements set by the Human Research Ethics Board, the ICE team was chosen as the vehicle for recruitment. This also eliminates the researcher's bias of participant selection and ensures participants are from a wide range of backgrounds and experience. As a result, all seven Ministry divisions are represented in the interview participant

cohort. Twenty-three people had expressed interest in participating. Applying the screening criteria, e.g., no close colleagues or friends, the 23 applicants was reduced to 16. The researcher shared the thesis proposal as background material with all 16 interested Ministry of Health staff members. After reviewing the thesis proposal, 15 out of the 16 interested members committed to participate. The distribution of the 15 interview participants across seven Ministry divisions are: Finance and Corporate Services (n=1), Health Sector Information Management / Information Technology (n=1), Health Sector Workforce (n=1), Population and Public Health (n=1), Health Services Policy and Quality Assurance (n=4), Pharmaceutical Services (n=2), and Health Sector Planning and Innovation (n=5). Representatives from all divisions in the Ministry participated in this research.

4.3.3 Interview

The 15 interviews occurred throughout April, 2015. Each interview was an hour long with a 15-minute presentation for background information and model familiarization, a 30-minute questions and answer period, and a 15-minute discussion. The 10 interview questions (see [Appendix K](#)) were adapted from Sterman's (2000, p. 852) *Business Dynamics* textbook. The 10 questions validate the *Web of Measures* model in five areas: purpose, structure, boundary, variables, and pragmatics. The first six questions are close-ended with options of Yes or No. Most participants chose yes or no answers to these questions, but some elaborated their reasons with more descriptive responses. The latter four questions are open-ended. The length of answers from participants varied.

4.3.4 Feedback

Data collected from all 15 interview participants provided feedback and comments about the model and this research. The *Web of Measures* model received a mixed review with more

approvals than criticism. Some participant comments point out a strong desire to adapt systems thinking across the Ministry in various areas of work such as population and public health, corporate and strategic planning, and policy design and development. All recorded participants' feedback and comments, with highlighted contents for model improvement, can be reviewed in [Appendix L](#).

4.4 Interview Feedback Analysis

The analysis of interview data adapts one of the three common content analysis techniques used in qualitative research: summative content analysis. Although each of the three qualitative content analysis techniques (conventional, directed, and summative) has its own characteristics, they are all used to extrapolate meaning from the content of text-based data (Hsieh & Shannon, 2005). Conventional content analysis is generally used in studies that aim to describe a phenomenon. Directed content analysis is used when previous research is insufficient to describe a phenomenon and subsequent investigation in the subject area can benefit the current practice. Summative content analysis is administered to identify certain words or phrases in text with the purpose of discovering the contextual meaning of the content (Hsieh & Shannon, 2005). Researchers often report using the summative approach to qualitative content analysis in studies that analyze manuscripts, journal articles, and interviews. As data collected from the 15 model validation interviews are text-based and an interpretation of participant feedback and comments is required to validate and potentially improve the model, the researcher believes summative content analysis is the most suitable approach to analyze interview data. This section summarizes data collected for each interview question.

Question 1: Is the purpose of the proposed system dynamics performance measurement system model clear to you?

All 15 participants answered yes to this question (n=15). This validates that the purpose of the model is clear. Extra comments include “knowing the relationships among the variables helps to know the purpose” and “[the purpose] is clear because the model identifies policy levers to increase sustainability.”

Question 2: Is the proposed model structure consistent with the structure of the Health Quality Matrix proposed by the BC Patient Safety & Quality Council?

All 15 participants answered yes to this question (n=15); however, two participants said more can be added. In particular, both participants observed that only five out of the seven dimensions of quality according to the BC Patient Safety & Quality Council are included. The other two dimensions – efficiency and equity – are also important to health system sustainability. One participant pointed out that effects of drugs on the system is worthwhile to consider. Also, health equity across different patient population can be measured in a future quantitative analysis using this qualitative model. Some supportive comments include “you’ve pulled in all the factors and dimensions from the BC Health Quality Matrix” and “this is the best use of the BC Health Quality Matrix I’ve seen.” Overall, interview responses indicate the model structure is consistent with the current work in BC performance measurement, but that other dimensions might be added.

Question 3: Can you see the BC health system boundary in the model?

All 15 participants answered yes to this question (n=15). One participant pointed out the ‘health education’ variable can be situated on both borders of health and education systems.

Question 4: Are the salient dimensions for addressing health system sustainability reflected in the model?

Fourteen out of 15 participants answered yes to this question (n=14); one participant answered “mostly.” One participant mentioned the current model was very medical-based and physician-centred. Another participant raised the importance of including the economic dimension and stressed its effects on health system sustainability, which might make economics more dominant. Socioeconomic factors should be linked to the healthy lifestyle and behaviour variable. The affordability and accessibility of healthy foods is a good measure to have. Although the model can be improved, the current five dimensions appear to be appropriate for addressing health system sustainability.

Question 5: Are internal and external health system variables demonstrated in the model?

All 15 participants answered yes to this question (n=15). One participant recommended redesigning the system to expand its inclusions list so that more variables can be considered internal. Another participant stated safety measures can include more than infections. Falls and the preventive actions around falls are also examples of safety measures.

Question 6: Are the causal relationships among the variables clear to you?

Fourteen out of 15 participants answered yes to this question (n=14). One participant was clear on some causal relationships, but not all of them. One participant raised the concern on the validity of variable associations. Another participant said the inclusion of the red line to show the main story is a good technique.

Question 7: Do you see any relevant health system components for measuring the performance of BC health system that are not included in the model?

Responses from participants indicate there are more system variables that need to be included (n=11). While four participants said they did not see any other relevant variables that needed to be included, eleven participants agreed that this model may benefit from other system components. Their comments are summarized below:

- Social determinants of health (affordability) can be categorized under the economic system, which should be included in the model (n=10). The Economic system can influence the healthy lifestyle and behaviour.
- Preventive care is not reflected in the model (n=9).
- IM/IT functions (e.g. innovations and Electronic Health Records) are missing (n=7). Technology can increase care capacity.
- Environmental variables should be represented (n=7).
- Strategic health human resource (HHR) implementation can expand care capacity (n=5).
- Team-based care (n=5), appropriate use of health services (n=5), and safety issues from too many tests for patients (n=5) should be considered.
- Staff engagement within the system such as health practitioner burnout rate, health workforce injury rates, health worker satisfaction, and productivity is important (n=4).
- Patient choice of health services can have impacts on wait time (n=2).
- Other missing variables include: adverse events related to drugs (n=1), recruit and retain health professionals (n=1), patient responsibility (n=1), and the proficiency of surgeries and follow-up care after need to be included (n=1).

Question 8: Are there other performance measures for the identified performance dimensions related to quality and/or sustainability missing from this model?

Two participants commented the current inclusion of performance measures in the model suffice for its purpose. Others have provided fascinating comments (n=13):

- The current model needs to be less hospital centric (n=7).
- Injuries and falls should be included under the Safety dimension (n=7).
- Efficiency measures, such as the number of Lean initiatives implemented, have impacts on care capacity (n=6).
- Economic measures focusing on finance and income can create stress and further impact population health (n=5).
- Having well-trained staff is important. Health practitioner education level should be included (n=5).
- Accessibility and affordability of healthy foods are joint measures of economic and health systems (n=5).
- There are mini feedback loops within the model (n=5). For example, wait time for care should point back to patient length of stay. Infections should point back to ED readmission.
- Patient choice: treatment options for patients; number of supporting services for different stages of life; alternative care vs. western medical treatments (n=2).
- Types of practitioners assigned to rural communities (n=1).
- The higher the social integration, the higher the number of informed family/social care givers; hence, the higher the social capacity to support care (n=1).

Question 9: Can you see how the BC Health System Matrix¹² data can be applied in the proposed model to measure, monitor, and report on the performance of the BC health system?

All participants report that they are able to see how BC Health System Matrix (HSM) data applies to the model (n=15). One participant said, “I’m not familiar with the HSM... however, from hearing your explanations and examples, I agree and can see the benefits of having HSM data applied in the proposed model.” Another participant stated that the population segments data from the HSM would provide detail-level information on their experience throughout the care pathway.

Are there other BC health and social data that you see suitable for the proposed model?

Most participants agreed that other BC data would be suitable for the proposed model (n=12); only three participants stated that what the model currently has would suffice (n=3). The following list is a summary of what participants suggested:

- Socioeconomic status data (n=10) such as income, education, housing, employment, and food.
- Fitness tax credits, bike lanes, and smoking cessation programs are sample data for a new variable called “Reduction of Barriers and Increase of Incentives” (n=10).
- PREMs and PROMs data may be helpful for the model to evaluate patient experience and therefore improve care processes (n=8).
- Number of malpractice complaints and/or patient care quality office complaints, which are safety and quality concerns within the health system (n=6).

¹² An introduction of BC’s Health System Matrix can be reviewed here:
http://www.cihiconferences.ca/usersday/downloads/presentations/Session_1_-_M_Burd_Halifax_Data_User_BC_matrix_2014_final.pdf

- Early years development instrument (EDI) and middle years development instrument (MDI) data may be helpful (n=5). Test results from schools to show education proficiencies.
- Patients' own self-monitoring devices such as computer fitness applications may lead to less reliance from patients on the formal health system, resulting in a decreased use of health services (n=4).
- Assumptions need to be validated. A future quantitative analysis based on this model may be meaningful to examine health behaviour and experience of a particular population segment (n=2).
- Rates of income assistance use (n=1).

Question 10: Do you agree that the proposed qualitative system dynamics approach to performance measurement in this research could improve the performance measurement and quality improvement for sustainable health service delivery in BC? If so, how so? If not, what would you recommend?

Almost all participants agreed that the proposed model (n=14), *Web of Measures*, could be beneficial to improve performance measurement and quality improvement in BC; one participant said, "Possibly." Below are some quotes of what participants said:

- "System managers need to understand causal and feedback relationships among system variables, so this research will be helpful."
- "I see this model can validate and identify extra information for decision makers for identifying policy levers. This model can serve as a new way of identifying relevant external variables. The identification of external variables can help the province to fund critical programs in a sustainable way."

- “Using this type of model could really help politicians and executives to decide the best places to allocate or concentrate efforts and resources.”
- “Seeing how delineated the causal relationships are is helpful.”
- “I liked the story you highlighted in the model. Linking together hard and soft variables impacting sustainability is very helpful.”
- “It’s important that we understand the causal relationships and the real areas we can leverage both policy and resource to become sustainable.”
- “The causal feedback loop can help identify better or more appropriate performance measures. The inclusion of PREMs and PROMs measures in this model is a good consideration of feedback measures.”
- It takes a “sustained commitment” to follow through on sustainability efforts. “Increase and improve child health care can impact health system operations in 20 years. Long term vision and commitment are needed.”

A pre-validation model, *Web of Measures*, was constructed based on the knowledge gained from the literature review and the researcher's mental model of the current situation in the BC health system. After the ethics approval was obtained, the researcher worked with the Internal Communications and Engagement team at the BC Ministry of Health to recruit participants for a series of model validation interviews. Fifteen interviews were conducted at the Ministry and the responses were gathered to validate and improve the pre-validation model. Based on the researcher’s further reflection on the model and the interview data, the *Web of Measures* has been updated and will be discussed next.

4.5 Post-validation Model

Data collected from the model validation interviews validate the *Web of Measures* model and provide information to improve the model. No model can ever be fully verified or validated (Sterman, 2000). All models, mental or formal, are simplified representations of the real world (Wolstenholme, 1990). The concepts are important for modellers to recognize because model validation is a continuous process. As the real world changes, models need to be updated through an iterative process to reflect reality accurately. Consequently, although the post-validation model in this research is an improved product from the pre-validation model, it should not be construed as a solution to all of the problems within the health system. Rather, the post-validation model is a step towards assisting health system managers to measure performance in a holistic way to support health system sustainability.

Responses from questions 1-6 validated that the purpose, structure, boundary, and variables of the model are clear.

- All participants report that they can see the purpose of the model, which is to enhance performance measurement in BC to support the sustainability of the provincial health system.
- All participants agree that the model structure is consistent with the current performance measurement practice in BC. The five performance dimensions from the BC Patient Safety & Quality Council are important to include; however, the efficiency and equity dimensions are also critical to consider.
- All participants are able to recognize the health system boundary. One comment is that some variables are more suitable to locate on the borders of different systems because shared accountability has been incorporated in the updated model. Another comment that

has been reflected in the post-validation model pertains to the inclusion of other systems such as economic, environmental, and education systems.

- Responses show that the set of variables demonstrated in the *Web of Measures* model appear to be reasonable and that the causal relationships between them are clear. A few comments point out that some of the high-level categories of measures may be more inclusive. For example, the safety dimension contains more than just care-related infections. Variables such as injuries, falls, number of malpractice complaints, and misdiagnosis are all safety concerns.

Upon further reflections on the model after the completion of all 15 model validation interviews and discussions with the thesis committee members, the researcher made the following updates to the *Web of Measures* model prior to applying modifications based on interview feedback:

- Different shapes of variables need to be changed to one shape. Too many shapes create confusion. For example, in process flow diagrams, it is universally accepted that diamond shapes are for decisions.
- Terms used in the model need to be updated to avoid confusion. For example, occupancy rate is used exclusively to refer to the utilization of hospitals. Therefore, “occupancy rate” has been changed to “hospital occupancy rate”. The term “ED readmissions after hospital discharge” is misleading as patients are not admitted to the ED. This term has been updated to “Readmissions through ED after hospital discharge”.

All relevant interview feedback to the improvement of the *Web of Measures* model has been included in the post-validation model. The relevancy of the feedback is determined by the number of people (represented by n=# in Section 4.4 Interview Feedback Analysis) that mention

the key words or phrases and the validity of the relationships between variables. Since it is an upgrade from the *Web of Measures* model, the post-validation model is named, *Web of Measures 2.0*¹³ (see Figure 42).

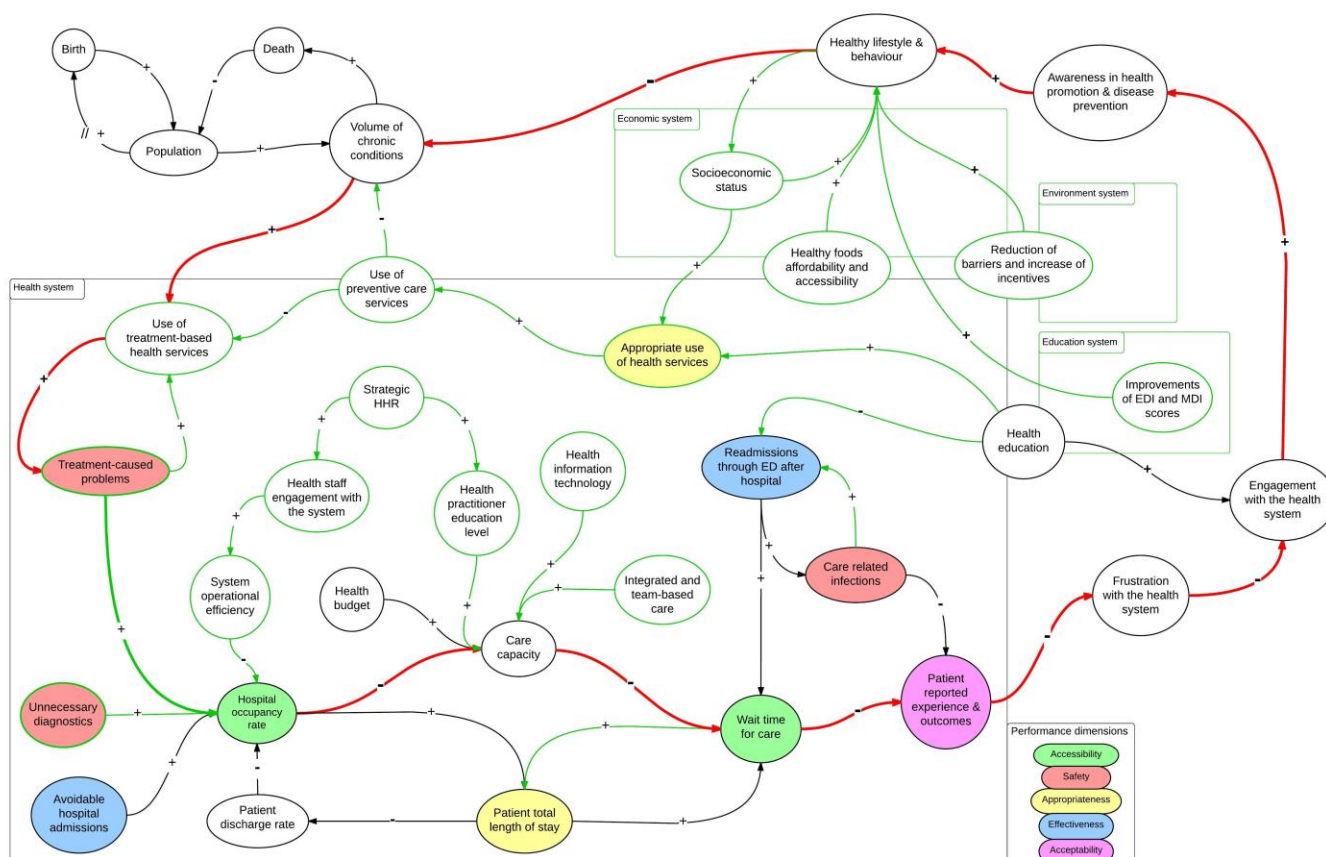


Figure 42: Post-validation Model - *Web of Measures 2.0*

Questions 7-10 are open-ended questions, allowing participants further to elaborate on their ideas. Responses from all 10 interview questions (see [Appendix L](#)) are analyzed. Improvement suggestions are included in the updated model and are highlighted in green (see Figure 42). These enhancements can be grouped into five themes:

¹³ A larger version of *The Web of Measures 2.0* can be reviewed in [Appendix M](#).

Theme 1: Including efficiency and equity performance dimensions

- Participant responses point out that the efficiency dimension is necessary to include (n=6) and it may impact the occupancy rate within the system and further affect care capacity. This enhancement is included in the model as the ‘system operational efficiency’ variable and has a negative association with the occupancy rate. A sample measure of the ‘system operational efficiency’ variable may be the number of Lean initiatives implemented around the health system. As more programs have “leaner” processes, health services can be delivered more efficiently; therefore, the occupancy rate may fall. Efficiency measures are extremely complex and should be implemented with caution as they can be taken advantage of for payment-related incentives and introduce unintended consequences later in the care pathway.
- While the equity dimension is critical also (n=2), equity issues such as the delivery of health services to people of different cultures, ages, genders, and geographic locations are better addressed in a more detailed-level, quantitative analysis. Similar to four areas of care in the Health Quality Matrix, the population variable in *Web of Measures 2.0* can be subdivided into different segments. Quantitative analytical results using different population segments such as mental health patients, seniors, and people with high complex chronic conditions may be compared to evaluate their experience throughout the care process.

Theme 2: Reflecting shared accountabilities between systems

- Participants agreed that the ‘health education’ variable should be included in the pre-validation model as an external variable influencing health system sustainability (n=12). Educating school children and adults about health promotion is often a shared

accountability between health and education systems and should be reflected in the model (n=6).

- Economic and environmental systems are proposed as external systems influencing health system sustainability (n=11).
- Two other variables identified with shared accountabilities are: ‘healthy foods affordability and accessibility’ (n=5) and ‘reduction of barriers and increase of incentives’ (n=10). The health system can raise the awareness of different types of healthy foods and the economic system may make healthy foods more affordable and, therefore, more accessible. A sample measure of this variable could be the number of local, organic foods available in grocery stores with prices that are matched or lower than the imported foods. This variable is positively associated with the ‘healthy lifestyle and behaviour’ variable. The ‘reduction of barriers and increase of incentives’ variable is a complex one and was inspired by multiple participants’ comments. Sample measures for this variable include smoking cessation programs, air and water qualities, building of bike lanes, fitness tax credits, providing free health coaching services, and offering MSP premium discounts to those who meet health standards. This variable contains creative and innovative ideas for policy design and development. A joint effort from multiple systems is required to successfully implement these policies.
- Another variable located on the health system boundary is the ‘use of preventive care services’ variable (n=9). Although preventive care services are considered as subsets of a range of health services, the use of new health technologies e.g., fitness apps, wearable sensor-oriented technologies, and diabetic home testing kits could raise people’s awareness of their own health status (e.g., resting heart rate, blood sugar, and body mass

index) thereby promoting self-management of diseases, leading to less reliance on the medical-based health system, and decreasing the use of treatment-based health services. A higher use of preventive care services may ultimately lower the volume of chronic conditions.

Theme 3: Redesigning the health system

- Interview responses indicate that the current health system in the model is too “hospital-centric” and treatment-based. (n=7) Also, there was no mention of health resource management, which may have a substantial influence on care capacity. Therefore, some changes were made in the model: 1) health resource management (n=5), 2) treatment-caused problems (n=5), and 3) appropriate use of health services (n=5).
- A number of variables are adapted from interview responses about health resource management. The ‘strategic health human resource’ variable may strengthen ‘health staff engagement with the system’ and the ‘health practitioner education level’ variables. The more health staff are engaged with the system, the higher the system operational efficiency may be; therefore, decreasing the occupancy rate. The staff engagement variable may also include the recent movement of increasing health staff in rural areas to meet health needs in more remote areas. As health practitioners increase their education level, better interventions can be recognized and which may increase care capacity. Health information technology, e.g., better access to patient information and interoperable Electronic Health Records and integrated care team-based care, e.g., integrated primary, community, acute, and specialist care may also increase care capacity. As an internal policy lever, the care capacity variable can be influenced by

many other variables. As this variable changes, subsequent changes in the model can create a ripple effect in the system.

- Although the health system is adequate in addressing patients' needs, it can also generate its own problems. Some participants point out that there are chronic conditions or adverse events caused by pharmaceutical products that often bring patients back into the medical system. For example, some atypical antipsychotic drugs will cause weight gain and diabetes. This phenomenon is reflected in the model by the reinforcing loop of 'use of treatment-based health services' and 'treatment-caused problems' variables. The 'use of preventive care services' variable can balance out this reinforcing loop and is also critical to the sustainability of the health system.
- The 'appropriate use of health services' variable is added to indicate that the health system is comprised of more than treatment services. Health consumers should be educated to understand that the health system is capable of offering services such as health prevention and maintenance. If patients are supported with choices on a variety of affordable and accessible health services, it may encourage the appropriate use of the health system. Socioeconomic status may also influence the way health services are used. The appropriate use of health services from all residents may subsequently contribute to a higher adoption of preventive, positive health practices, and a decrease in the reliance on treatment-based health services.

Theme 4: Strengthening external factors

- Economic, environment, and education systems are added in the model because health system sustainability is dependent on the overall wellbeing of the population, which is affected by the environment in which people live (n=7). All three added systems play

essential roles in social determinants of health. Sample factors for environmental and social determinants of health include unemployment, working conditions, poverty, transportation policies, social support, socioeconomic status, and physical environment.

One participant explained that social integration is an overlapped area by multiple systems such as environmental, education, and economic systems. “The higher the social integration, the higher the number of informed family/social care givers; hence, the higher the social capacity to support care.” In addition to the two shared accountabilities variables, two other variables are added as external factors: improvements of EDI and MDI scores (n=5) and socioeconomic status (SES) (n=10).

- Research has shown that early childhood education has a lasting impact on individual’s health and wellbeing (Bezruchka, 2015). Early Development Instrument is a questionnaire used by kindergarten teachers to assess a child’s school readiness in five domains: physical health and wellbeing, language and cognitive development, social competence, emotional maturity, and communication skills and general knowledge. Middle-years Development Instrument is similar to EDI in principle, but different in practice. MDI is a self-report questionnaire completed by children from Grade four to seven. MDI questionnaires include five areas of development: physical health and wellbeing, connectedness, social and emotion development, school experiences, and use of after-school time. Results collected from EDI and MDI questionnaires can encourage families to take on healthier lifestyle.
- SES data such as income, housing, and employment are important variables to consider and will positively impact a population’s healthy lifestyle and behaviour. This is supported by findings discussed in the literature review. Similar to health inequalities

and population segments, the three categories of SES (high, middle, and low) can be applied in a subsequent qualitative analysis using this model.

Theme 5: Connecting other variables

- After explaining the major enhancements in the above four categories, the fifth category includes the final and necessary linkages of causalities to complete the model. Responses noted that some causes may also be effects and are indicated as such with arrows pointing back to itself (n=5). Such feedback loops may hold true, and have been reflected in the model: a higher wait time for care, e.g., seniors waiting in hospital for home support and rehabilitative care in the community may also lead to a higher patient total length of stay, e.g., Alternate Level of Care; and more hospital care-related problems could cause more post-discharge readmissions through the ED. These are mini reinforcing loops within the model and can often be balanced out by other variables. One participant pointed out that health education may decrease ED readmissions after hospital discharge. The inclusion of this linkage reflects the importance of patient follow-up care after acute care discharge. When patients understand what to do, e.g., when to take medication and how often, when to check blood pressure, and how to test for blood sugar levels, after being discharged from a hospital stay, there may be fewer emergency readmissions to hospital.
- Misdiagnosis or unnecessary lab tests for patients is a performance measure under the Safety dimension (n=7). Because of concerns about safety and its potential to make the health system inefficient and ineffective, it is essential to include.

Interview feedback with a low frequency of mentioning from participants – for example, patient responsibility (n=1) and the rate of income assistance use (n=1) – are not included in the model. Although not every feedback from the model validation interviews is included in the

post-validation model, *Web of Measures 2.0* has been improved significantly compared with the pre-validation model. The six closed-ended questions in the first half of the interview validate the model's purpose, structure, boundary, and variables. The four open-ended questions during the second half of the interview provide detailed responses to improve the model in its development and practicality.

4.6 Summary

Chapter Four describes Step 4 to 10 in the research methodology in detail. *Tree of Measures* was developed (Step 4) based on the current practice of performance measures in BC. The five dimensions of quality are the chosen performance dimensions in both BC Health System Strategy and BCPSQC's Health Quality Matrix. Therefore, these five quality dimensions are a good starting point. The qualitative system dynamics method was applied to model the future, desired state of performance measurement: *Web of Measures* (Step 5). The substantial enhancement from the *Tree of Measures* model is that the *Web of Measures* model promotes the interrelationships among variables both internal and external to the BC health system. After receiving the human research ethics approval, the process of conducting model validation interviews was described (Step 6-8). Interview responses are helpful to validate the model structure and purpose (Step 9). The collected data are also important for improving the model (Step 10). All relevant ideas about the improvement of the model are grouped into five themes and are included in *Web of Measures 2.0*. Here is a list summarizing all the improvement points made from *Web of Measures* to *Web of Measures 2.0*:

- Changed all shapes to oval shape to avoid confusion.
- Renamed “occupancy rate” to “hospital occupancy rate” and “ED readmissions after hospital discharge” to “Readmissions through ED after hospital discharge”.

- Added the education system, the economic system, and the environmental system to demonstrate external influences on the health system.
- Added “health education”, “healthy foods affordability and accessibility”, and “reduction of barriers and increase of incentives” variables as shared accountabilities.
- Added the “improvements of EDI and MDI scores” variable in the education system.
- Added the “socioeconomic status” variable to represent the economic pillar of sustainability.
- Added the “use of preventive care services” variable and placed it on the health system boundary because some preventive care services are from the health system and some can come from individuals that are external to the health system.
- Added “use of treatment-based health services” and “treatment-caused problems” to show the current health system can be used as a hospital-centric and medically-oriented system.
- Added “unnecessary diagnostics” to impact “hospital occupancy rate”.
- Added the “appropriate use of health services” variable and its relationships with other variables.
- Added “health information technology”, “integrated and team-based care”, and “health practitioner education level” variables affecting care capacity.
- Added “strategic HHR”, “health staff engagement with the system”, and “system operational efficiency” variables affecting hospital occupancy rate.
- For all added variables, proposed causal relationships have been added to link variables and represent their interrelationships with each other.

All improvement points are highlighted in green and can be viewed in [Appendix L](#).

Chapter 5 Discussion

This chapter examines how the post-validation model benefits from the learning points through the literature review, discusses how research questions are addressed, and describes research limitations and opportunities for future research.

5.1 Examining the Post-validation Model

Chapter Four outlined the process of constructing the pre-validation model, conducting model validation interviews, and developing the post-validation model. This section of Chapter Five examines the relevance of the information provided in the literature review chapter and *Web of Measures 2.0* and how it compares with the Fischer (2015) Healthcare System Sustainability Framework. The learning points are summarized below:

- The introduction chapter of this thesis highlighted the problem of health system sustainability in BC; hence, this research began with answering conceptual questions around sustainability: what sustainability is defined as, what the foundational building blocks of sustainability are, and how sustainability applies in health system management. The seven strategies of sustainable development (Page 15) from the Brundtland Report (1987), the interdependency of the three pillars of sustainability (Page 17) from Adams (2006), and the five contexts of sustainability (Page 18) from Pappas (2012) support the understanding that sustainability cannot be achieved by studying individual system components in isolation, rather a system-wide examination including both internal and external system variables is required.
- International examples of tackling sustainability issues are reviewed. Results from studying the top performing sustainable health systems from OECD countries show an emphasis is put on both health system internal variables such as pharmaceutical costs,

information and communication technologies, and care providers' ongoing education and external variables including determinants of health and non-medical factors (Page 23).

The 2012 Sustainable Health Systems Project identifies similar findings: 1) use innovative technologies to transform health and care, 2) develop healthy living environments, and 3) promote disease prevention and self-management of health and illness (Page 25).

- The Health and Health care Sustainability Framework from the Conference Board of Canada (Figure 12 on Page 27) provides the Canadian context in health system sustainability. The comparison of the sustainability elements in the Health and Health Care Sustainability Framework with the ones included in the 2012 sustainability project and Alberta's Triple Aim Framework for Health System Sustainability can be seen in Table 4 on Page 35. This comparison confirms that the Health and Health Care Sustainability Framework has an extensive inclusion of sustainability elements and is suitable for this research to adopt.
- First and second generations of performance measurement systems are also reviewed to gain understanding in the development and improvement of performance measurement systems. Performance measurement practices before the first generation had a heavy focus on financial data. The first generation systems (Page 38-40) supplement the traditional financial measures with non-financial measures such as customer satisfaction, organizational capacity to learn and grow, and shareholder relationships. The second generation systems (Page 41-45) have improvements from the first generation by identifying the need to link system variables across performance dimensions, establish linkages between financial assets and business values, and embrace the dynamics of

value creation. The first generation systems also tend to measure performance in isolation, and the second generation systems emphasize the linkages among performance variables. This observation is reflected in the review of the CIHI-Statistics Canada Health Indicator Framework (Figure 21 on Page 47), which is categorized as the first generation system, and the CIHI Health System Performance Measurement Framework (Figure 22 on Page 49), which is considered as a second generation system. The CIHI framework is compared with international frameworks (Table 5 on Page 53) and shows a wider inclusion of performance dimensions. Besides being a second generation and Canadian national performance measurement framework, the CIHI framework is a great example for BC to follow. Although considered to be a first generation system, the Alberta performance measurement framework (Figure 26 on Page 60) and its measurement classification approach (Figure 27 on Page 62) offer learning points for BC because it is closely aligned with the national framework from CIHI. Alberta's cascading accountabilities for performance reporting (Figure 28 on Page 64) also offers positive examples for BC to adopt.

- The review of literature on health system sustainability and system performance measurement informs the researcher that developing an effective performance measurement system requires a systems approach. Obtaining sustainability in health systems relies on the balance between the supply of health services and the demand for care from the population. The realization of this balance leads to the adoption of system dynamics for this research as well as the development of the conceptual framework (Figure 37 on Page 97) for *Web of Measures 2.0*.

The changes shown between the *Tree of Measures* and the *Web of Measures 2.0* figures are somewhat similar to the evolution from CIHI's Health Indicator Framework in 1999 to its Health System Performance Measurement Framework in 2013. Visually, both the CIHI Health Indicator Framework and the *Tree of Measures* diagram compartmentalize performance variables into different dimensions. While the identification of these performance dimensions are important, the downside is that the measurement of system performance focuses too much on individual dimension and therefore, measuring the performance of subsystems. The *Web of Measures 2.0* model aligns with CIHI's new performance measurement framework in that they both emphasize the linkages among performance variables as well as including external influencing factors. This alignment between the provincial-level and the national-level performance measurement systems may provide BC Ministry of Health further incentive to adopt the proposed model: *Web of Measures 2.0*.

The most recent publication on sustainable health systems is the Fischer (2015) Healthcare System Sustainability Framework (see Figure 43). Fischer examined similar health system sustainability literature to what this research reviewed. Therefore, it is meaningful to compare Fischer's framework with *Web of Measures 2.0*. Fischer proposed five categories for developing a sustainable healthcare system: long-term strategic perspective and innovativeness; disease prevention and health promotion; quality; institutionalization of environmental concerns; and institutional accountability and individual responsibility. Although not using the exact same terminology, the first four categories have been included in *Web of Measures 2.0*. Institutional accountability means "the importance of including many stakeholders in the decision-making process" (Fischer, 2015, p. 306). This point is also reflected in the shared accountabilities variables in *Web of Measures 2.0*. What the proposed model from this research did not include

is the “individual responsibility” perspective. This research also found supporting points on “individual responsibility”. Papas (2012) states that individual sustainability, one of the five contexts of sustainability, refers to individuals living a sustainable lifestyle which consists of interconnection and awareness of one’s values, beliefs, and behaviours in disciplining one’s physical, emotional, social, environmental, philosophical, and intellectual life. Patient responsibility was proposed by an interview participant as a missing variable in the pre-validation model. Because it did not meet the requirement for inclusion ($n > 5$), it was not included in the post-validation model. However, the exclusion of this variable does not mean it is not important to health system sustainability. The literature supports that performance measurement needs to shift from using only objectivity to including subjectivity. As surveys and questionnaires in PREMs and PROMs become more mature and establish solid ground to support health system sustainability, the subjective point of views from individual responsibility should also be included. Patient responsibilities are powerful influencing factors to the demand on the health system. It is only when the population is empowered to take ownership of their individual health, that the health system can be fully capable of treating the ones recovering from illness and supporting those maintaining optimal health status and outcomes.

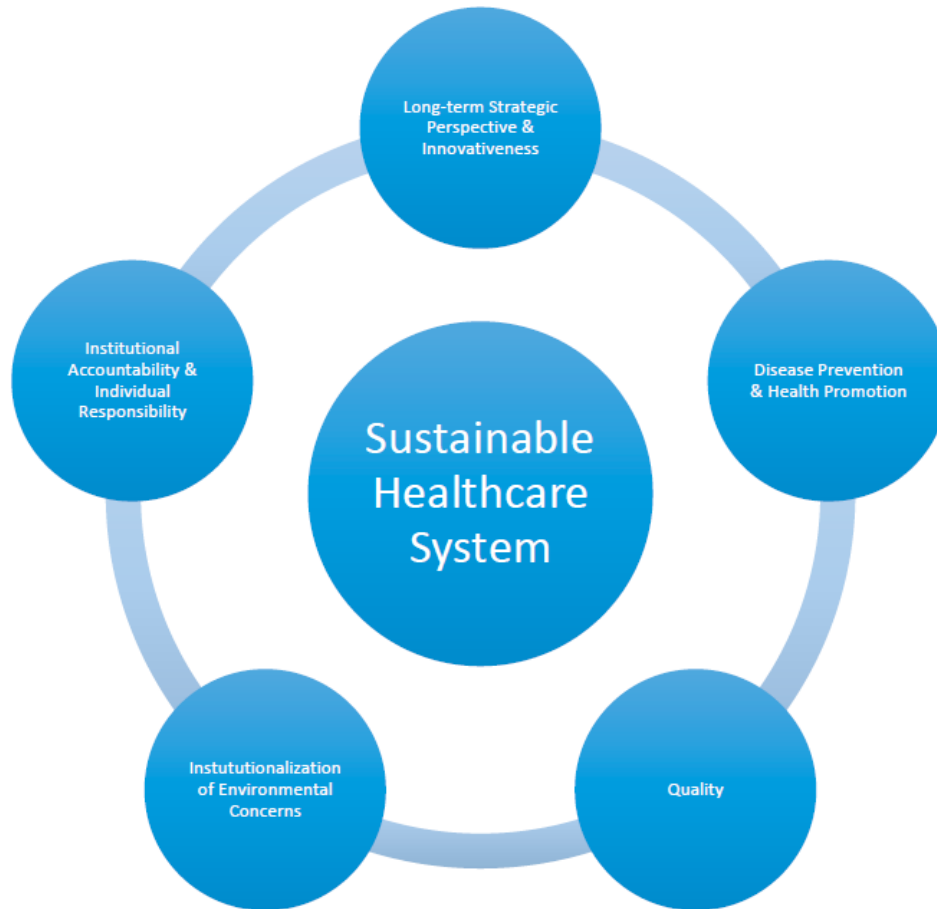


Figure 43: A Conceptual Framework for a Sustainable Healthcare System (Fischer, 2015)

5.2 Addressing Research Questions

After going through the 10-step research methodology, the researcher arrived at *Web of Measures 2.0*. As the product of this research, the post-validation model has the potential to improve current performance measurement in BC. The research process has helped the researcher acquire greater insights into the three research questions proposed at the beginning of this research:

Research Question #1: What are the structural variables and the interrelationships between them that impact the sustainability of the BC health system?

At the macro level, health system sustainability cannot be achieved by focusing only on the management of the health system. The purpose of any health system is to maintain, protect, and improve the wellbeing of its people. Population health relies on the environmental and social determinants of health. Therefore, if the population is not healthy, the demand on health system is for treatment-based services. As indicated in the *Web of Measures* model, without considering the external factors, when the demands on a health system increase, the health system is put into a reactive position. The realization of this reinforcing feedback loop is the first step in attaining health system sustainability.

Internal to the health system, BC Patient Safety & Quality Council's seven performance dimensions from the Health Quality Matrix are important variables to include. Six of the seven dimensions are reflected in the *Web of Measures 2.0*; the equity dimension is better evaluated at the detailed level using quantitative analyses. The interrelationships between these variables are important to consider. All seven performance variables can be causes or effects depending on their positions in the care pathway. It is not difficult, however, to see in the model that the acceptability dimension contains outcome measures, e.g., PREMs and PROMs, and all of the other dimensions offer process measures. Health-related activities that occur within the health system boundary contribute to ensuring that health service consumers are satisfied when they are ready to exit the system.

Variables from external systems such as environment, economic, and education are critical to maintaining a healthy population. It is only when the population is healthy that demands on the health system are minimal and the system can respond quickly with appropriate services. Some key external variables include socioeconomic status, barriers reduction and incentives increments, and education data such as EDI and MDI scores.

Research Question #2: What is the story behind the interrelationships among system variables and how can policy levers be identified to achieve health system sustainability?

The main story in *Web of Measures 2.0*, linked by red arrows, is a reinforcing feedback loop that illustrates that the sustainability of the BC health system is dependent on two key factors: 1) individual characteristics such as health status, socioeconomic status, and environmental attributions of BC residents as they enter the health system, and 2) health consumer-reported experience and outcomes as they leave the system. By understanding the interrelationships, policy and decision makers may be better enabled to develop appropriate solutions to improve the health system.

Care capacity and health education, the two policy levers identified in the *Web of Measures* model, have been validated via the model validation interviews. Care capacity, as an internal policy lever, is a key variable because it influences many performance dimensions. In *Web of Measures 2.0*, health resource variables are shown to impact care capacity. As a result, if health resources can be managed effectively, there may be adequate capacity within the health system to provide appropriate, safe, and effective services. Although ‘health education’ is an important variable to include, interview responses indicate that the variable ‘healthy lifestyle and behaviour’ may be more important. *Web of Measures 2.0* presents that once the main story is selected from a causal loop diagram, policy levers for managing health system performance become clearer.

Research Question #3: How can the proposed model assist in BC’s performance measurement practices for a sustainable health system?

The proposed model may assist performance measurement in BC in two ways: 1) shifting health system managers’ views of the health system and 2) developing performance measures.

Web of Measures 2.0 urges and proposes shifts in management's view of reality. Three major shifts need to take place to enhance performance measurement to support sustainable health systems.

1. A shift from looking at micro variables to macro variables. Sustainability cannot be obtained by looking at one system alone. System-level variables and their interrelationships often convey a clearer story in the context of sustainability.
2. A shift from investigating objectivity to incorporating subjectivity. Other modellers may use different terminology such as “from hard data to soft data” or “from tangibles to intangibles”. The idea is to include subjective viewpoints, e.g., patient reported experience and outcome data, to improve quality and maintain sustainability.
3. A shift from unidirectional causality to feedback causality. It can be argued that unidirectional causality is not an appropriate way to examine a complex system. Ignoring the feedback loops embedded at the structure-level between systems may obscure perceptions of problems. Identifying and understanding causality and feedback relationships provide better ways to regulate patterns of behaviour involving different systems.

Web of Measures 2.0 contains high-level categories of performance measures from *Tree of Measures*, which is the current state of performance measurement in BC. As policy levers can be identified within the model, performance measures can also be identified and used to monitor, evaluate, and report on the performance of the BC health system. It is important to state that model variables with identified interrelationships are established for this research within current contexts of British Columbia and its provincial health system. *Web of Measures 2.0* might look differently for other jurisdictions.

5.3 Describing Research Limitations

Sample Size for Model Validation

Due to the length of this research and the fulfillment of the requirement for the Master of Science degree as an academic exercise, the sample size for model validation is quite small. A real world research study on the topic such as developing a performance measurement model for health system sustainability will require a sample size of hundreds of participants to conceptualize, construct, and validate research milestones and outcomes. A team of researchers and consultants would be ideal to take on a project scale as large as this one, compared to this research conducted by a graduate student, a thesis supervisor, and three committee members.

Besides the fact that the number of model validation interview participants is limited, the variety of participants' education, background, and experience is also limited. Again, due to the scope of this research, the researcher only applied for human research ethics within the confinement of BC Ministry of Health. Ideally, designing a performance measurement system to monitor the provincial health system should include all levels of staff members such as health system executives, care providers, and performance evaluators from various health organizations such as health authorities, research agencies, and patient networks.

Selection of Interview Participants

The interview participant cohort was initially defined to include selected BC Ministry of Health staff and representatives from the health authorities with knowledge about BC health system performance measurement and management. Once the research scope and length were finalized, the inclusion of health authority representatives was removed because the Ministry staff's perspective on the proposed model suffices at this stage of the research. If the Ministry is

interested in adopting the proposed model for enhancing performance measurement, *Web of Measures 2.0* can be presented to the health authorities for further validation and improvements.

The research committee advised the researcher not to select interview participants on his own as it violates human research ethics standards and requirements due to bias and unfairness. The first version of the Human Research Ethics Application states that the recruitment of interview participants would be sent out via email from one of the committee members. The Human Research Ethics Board questioned the power-over relationship of the recruiter and interview participants. Therefore, the application was revised to use the Internal Communications and Engagement team at the Ministry to recruit the interviewees.

The change of using the ICE as the recruiter for this research was game-changing because via advertisement and recruitment, this research gained Ministry-wide attention. More than 20 people from multiple work sites, e.g., Victoria, Duncan, and Vancouver, approached the researcher to discuss the research. All seven Ministry divisions were represented from the 15 committed participants. Although not perfect, the post-validation model received positive reviews from all participants.

Although the selection of interview participants was somewhat limited and the selection process was not what the researcher had envisioned, the researcher was able to work with the thesis supervisor and committee members for a solution. The solution benefited this research as it avoided biases in interview responses and gained feedback from Ministry staff located in multiple job sites and various knowledge domains. The justification of this limitation in selecting interview participants was acceptable when considering the research scope, length, and purpose.

Exclusion of Some Interview Feedback

The 15 model validation interviews provided many excellent points to improve the pre-validation model. Many of them have been included in the post-validation model and discussed in the previous section. However, due to the current stage of modeling and the scope of this research, not all of them were included. For example, a couple of interview participants raised the point about including “patient choice” as an internal variable to the health system. As the health system becomes more capable in providing various types and levels of care to patients, more care options can be available for patients to choose from. Once patients are aware of the choices they may take, it may result in an increase in the appropriate use of health services, a decrease in wait times, and an increase in patient experience and satisfaction. Nonetheless, we decided to exclude this variable because it is unlikely to collect evidence to support this claim and potential uncertainties could outweigh benefits.

Another interesting idea was to include the “pressure to succeed” variable within the economic system. “Pressure to succeed” would represent the societal pressure on children and adults to stand out financially and personally among peers. Even though this variable could increase an individual’s or a family’s socioeconomic status, it could also create psychological stress and foster unhealthy behaviours such as higher consumptions of low nutrient and high calorie foods and a lack of exercise. It seems like almost all economic variables have a positive association with the population’s healthy lifestyle and behaviour, “pressure to succeed” could demonstrate that societal and peer pressure may have a negative impact on individuals’ health. While this is a fascinating concept to consider, it would be difficult to collect data to support the argument. Additionally, the sample size might not be statistically significant to prove the idea.

There are other compelling variables brought up by the interview participants. A rich picture might be an appropriate way to display all the creative ideas. However, that is again limited by the length and scope of this research.

Need for Quantitative Analysis

A system dynamics-based research study is usually done applying both qualitative and quantitative analysis. This research focuses on the qualitative analysis due to two main reasons:

1. Research scope control: A research study examining concepts, developments, and applications of three topics (sustainability, performance measurement, and system dynamics) is already a handful. Adding quantitative analysis would exceed the expectation for the degree of Master of Science.
2. Importance of validation: Without adequate validation and verification of qualitative interpretations, subsequent quantitative analysis offer little value to system thinkers (Wolstenholme, 1990). Therefore, with the support from the committee, the researcher chose to conduct a qualitative study in this research. Although system modeling is a continuous effort and no models are fully validated at any point in time, the researcher hopes the essence of this research, which is to focus on system as a whole rather than in isolation, is clear to readers.

Highlighting the importance of accurate qualitative analysis, the researcher agrees that this research is limited by its lack of quantitative analysis. Opportunities for conducting quantitative analysis using the proposed qualitative performance measurement model, *Web of Measures 2.0*, are discussed in the next section.

5.4 Envisioning Future Research Opportunities

Interview questions 9 and 10 are designed to validate the applicability or pragmatics of the proposed model. Question 9 asks if participants can envision BC Health System Matrix data being inputted in the proposed model for quantitative analysis on health system performance. Question 10 asks if participants agree that the qualitative system dynamics approach can enhance performance measurement in BC. All participants answered ‘yes’ to both questions (n=15). Responses from the interviews indicate that performance measurement in BC can benefit from a systems approach, particularly the system dynamics method.

The BC Health System Matrix (HSM) is a database that summarizes all health services that each BC resident uses in each fiscal year and that have been reported to the Ministry starting from FY 2002/2003 (Burd, 2014). A summary table (see Table 11) applying the HSM data on BC population segments and their use of the provincial health spending in FY 2011/2012 shows that one percent of the BC population uses 25 percent of the health dollars. As previously mentioned, a detailed-level, quantitative analysis using the proposed qualitative model could hone in on that one percent of the population, which is the frail seniors population living in the community, monitor their health services utilization patterns along the care pathway, and evaluate the performance of the health system as they touch different care sectors. A quantitative system dynamics analysis using the *Web of Measures 2.0* could also simulate different scenarios of clinical interventions and health resource allocations to plan out the best available care option for the identified population segment. A system dynamics approach, as shown in this research, may assist to outline a better health dollar distribution plan by identifying policy levers, applying data for performance management, and supporting a sustainable health system to better meet population health needs.

Health System Matrix 5.0 <i>Estimate of the distribution of \$9.9 Billion of Selected Publicly Funded Health Services used by BC Residents in 2011/12</i> <i>Population Segments Assigned to their highest health care need in the year</i>	People (Thousands)		Millions of Dollars							Total Cost (Millions)		
			Primary Care (GP and Professional Home Nursing)	Specialists, Surgeons, Labs and Diagnostics	PharmaCare	Hospital Care (Inpatient & Day Surgery, not including Physicians)	Supports for Daily Living	Residential Care				
Healthy Non-Users	662	14%										0%
Maternity and Healthy Newborns	111	2%	\$ 29	\$ 148	\$ 5	\$ 188					\$ 369	4%
Healthy with minor episodic health needs	1,613	35%	\$ 150	\$ 199	\$ 11	\$ -					\$ 359	4%
Major or Significant time limited health needs: Adults	119	3%	\$ 26	\$ 122	\$ 51	\$ 203					\$ 401	4%
Major or Significant time limited health needs: <18 yrs	45	1%	\$ 9	\$ 47	\$ 8	\$ 180					\$ 244	2%
Mental Health and Substance Use needs	83	2%	\$ 19	\$ 100	\$ 94	\$ 225					\$ 438	4%
Population with Cancer	54	1%	\$ 26	\$ 107	\$ 28	\$ 284	\$ 12	\$ 1			\$ 459	5%
Low Complex Chronic Conditions	1,332	28%	\$ 235	\$ 520	\$ 221	\$ 404					\$ 1,380	14%
Medium Complex Chronic Conditions	383	8%	\$ 145	\$ 315	\$ 207	\$ 418					\$ 1,086	11%
High Complex Chronic Conditions	208	4%	\$ 156	\$ 311	\$ 251	\$ 958	\$ 236	\$ 17			\$ 1,928	19%
Frail Population, living in the Community	13	0%	\$ 16	\$ 17	\$ 24	\$ 82	\$ 158	\$ 7			\$ 305	3%
Frail Population, living in Residential Care	38	1%	\$ 27	\$ 50	\$ 44	\$ 381	\$ 48	\$ 1,912			\$ 2,462	25%
Palliative Needs	16	0%	\$ 31	\$ 41	\$ 27	\$ 271	\$ 32	\$ 57			\$ 458	5%
All Population Segments	4,675	100%	\$ 868	\$ 1,977	\$ 970	\$ 3,595	\$ 486	\$ 1,994			\$ 9,889	100%
			9%	20%	10%	36%	5%	20%			100%	

Table 11: A Table of Population Segments and Health Spending

Chapter 6 Conclusion

The purpose of this research is to develop a performance measurement model that may contribute to the sustainability of the BC health system. A 10-step, qualitative research methodology was applied to arrive at the proposed model: 1) define the problem BC is facing, i.e., the unsustainable health system; 2) review literature on relevant concepts, which are health system sustainability, system performance measurement, and system dynamics; 3) select the appropriate research methods, which are the qualitative system dynamics to create the model and conduct interviews with stakeholders to validate and improve the model; 4) describe the current state of performance measurement in BC, which is reflected in the *Tree of Measures model*; 5) model the future state; which is the pre-validation model called *Web of Measures* and is developed following the first phase of the qualitative system dynamics method; 6) apply for research ethics approval, which is useful in clarifying interview procedures and protecting participants' privacy and confidentiality; 7) recruit interview participants, which also helps this research to gain a wide recognition; 8) conduct interviews; 9) analyze interview data, from which relevant improvement ideas are extracted to validate and improve *Web of Measures*; 10) update *Web of Measures* (the pre-validation model) to *Web of Measures 2.0* (the post-validation model), which is the proposed model and the final product of this research.

Web of Measures 2.0 shows how policy levers that are internal and external to the BC health system, and performance measures can be identified to assist with policy design and development. In particular, *Web of Measures 2.0* points out that to achieve health system sustainability, care capacity (internal) and healthy lifestyle (external) are areas to focus upon when developing policies. In addition to the specifics in performance measurement at a strategic level, this research has identified three fundamental shifts in performance measurement and

management: 1) a shift from looking at micro variables to macro variables; 2) a shift from investigating objectivity to incorporating subjectivity; and 3) a shift from unidirectional causality to feedback causality.

According to Behn (2003), performance measurement by itself does not improve performance. Without proper intellectual and operational capacity to learn from analysis and results from performance measurement, no improvements in performance could ever be made. One of the interview participants said after the interview, “it takes a ‘sustained commitment’ to plan it out, stick it out, and follow through.”

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Appendices

Appendix A: Improvement Areas, Priorities, and Strategies in BC

- Improvement Area 1:** Effective chronic disease prevention through universal and targeted population health interventions that address all major risk factors across the life cycle.
- Improvement Area 2:** Reducing hospitalization and the need for residential care by preventing or slowing down the onset of frailty through targeted efforts to better manage the patient journey from low to moderate to more complex chronic conditions linked with aging/increased frailty.
- Improvement Area 3:** Effective community services for patients with moderate to severe mental illness and addictions to reduce hospitalizations.
- Improvement Area 4:** Increasing timely access to evidence-informed care from specialists, diagnostic imaging, and elective surgery to reduce wait times.
- Improvement Area 5:** Providing consistent quality of care for residential care patients, with a strong focus on quality of care for dementia patients.
- Improvement Area 6:** Effective and compassionate care for end-of-life patients.
-
- Priority 1:** Provide patient-centred care.
- Priority 2:** Implement targeted and effective primary prevention and health promotion through a coordinated delivery system.
- Priority 3:** Implement a provincial system of primary and community care built around inter-professional teams and functions.
- Priority 4:** Strengthen the interface between primary and specialist care and treatment.
- Priority 5:** Provide timely access to quality diagnostics.
- Priority 6:** Drive evidence-informed access to clinically effective and cost-effective pharmaceuticals.
- Priority 7:** Examine the role and functioning of the acute care system, focused on driving inter-professional teams and functions with better linkages to community health care.
- Priority 8:** Increase access to an appropriate continuum of residential care services.
-
- Strategy 1:** A shared plan of action.
- Strategy 2:** Accountability to deliver the three-year plan.
- Strategy 3:** Quality.
- Strategy 4:** Skilled change management.
- Strategy 5:** Health human resource strategy – an engaged, skilled, well-led and healthy workforce.
- Strategy 6:** Information management and technology.
- Strategy 7:** Budget management and efficiency.

Source: BC Ministry of Health — Health System Strategy (BC Ministry of Health, 2014b)

Appendix B: The 2005 CIHI Performance Framework with Definitions

CANADIAN INSTITUTE FOR HEALTH INFORMATION'S PERFORMANCE FRAMEWORK

Health Status			
Health Conditions	Human Function	Well-Being	Deaths
Alterations of health status, which may be a disease, disorder, injury or trauma, or reflect other health-related states	Alterations to body functions/structures (impairment), activities (activity limitation), and participation (restrictions in participation)	Broad measures of physical/mental/social well-being of individuals	Age or condition-specific mortality rates and other derived indicators
Non-Medical Determinants of Health			
Health Behaviours	Living and Working Conditions	Personal Resources	Environmental Factors
Aspects of personal behaviour and risk factors that influence health status	Socio-economic characteristics and working conditions of population that are related to health	Measures the prevalence of factors, such as social support and life stress, that are related to health	Environmental factors that can influence health
Health System Performance			
Acceptability	Accessibility	Appropriateness	Competence
Care/service provided meets expectations of client, community, providers and paying organisations	Ability of clients/patients to obtain care/service at the right place and right time, based on needs	Care/service provided is relevant to client/patient needs and based on established standards	Individual's knowledge/skills are appropriate to care/service provided
Continuity	Effectiveness	Efficiency	Safety
Ability to provide uninterrupted, coordinated care/service across programs, practitioners, organisations, and levels of care/service, over time	Care/service, intervention or action achieves desired results	Achieving desired results with most cost-effective use of resources	Potential risks of an intervention or the environment are avoided or minimised
Community and Health System Characteristics			
Characteristics of the community or the health system that, while not indicators of health status or health system performance in themselves, provide useful contextual information.			

Equity



Source: Canadian Institute for Health Information, *Health Indicators*, 2005.

Source: *Health Care Quality Indicators Project*. (Kelley & Hurst, 2006)

Appendix C: The 110 Performance Measures from CIHI Indicator Library

Indicator	Health System Performance Measurement Framework Dimensions
30-Day Acute Myocardial Infarction In-Hospital Mortality	3.4
30-Day Readmission for Mental Illness	3.2
30-Day Stroke In-Hospital Mortality	3.4
Administrative Expense	2.3
Age-Adjusted Public Spending per Person	2.2
All Patients Readmitted to Hospital	3.4
Ambulatory Care Sensitive Conditions	3.4
Assisted Delivery Rate (Overall) Among Vaginal Deliveries	2.4
Asthma Emergency Department Visits: Volume and Median Length of Stay	3.4
Average Gross Clinical Payment per Physician	2.2
Average Number of Drug Classes Used by Seniors on Public Drug Programs	3.4
Avoidable Deaths	4.1
Avoidable Deaths From Preventable Causes	4.1
Avoidable Deaths From Treatable Causes	4.1
Breastfeeding Initiation	3.4
Caesarean Section Rate	3.4
Cardiac Revascularization Rate	2.2
Children Vulnerable in Areas of Early Development	4.1
Coronary Artery Bypass Graft (CABG) Rate	2.2
Cost of a Standard Hospital Stay	3.5
Days Waiting for Admission to Inpatient Rehabilitation	3.1
Emergency Department Wait Time for Inpatient Bed	3.1
Emergency Department Wait Time for Physician Initial Assessment	3.1
Epidural Rate for Vaginal Deliveries	2.4
Experiencing Pain in Long-Term Care	3.4
Experiencing Worsened Pain in Long-Term Care	3.4
Falls in the Last 30 Days in Long-Term Care	3.3
Have a Regular Doctor	3.1
Heavy Drinking	1.2
Hip Fracture Surgery Wait Times	3.1
Hip Replacement Rate (All Types)	2.2
Hospital Deaths Following Major Surgery	3.4
Hospital Deaths (HSMR)	3.4
Hospitalized Heart Attacks	4.1
Hospitalized Hip Fracture Event	3.4
Hospitalized Strokes	4.1
Hysterectomy Rate	2.2
Improved Physical Functioning in Long-Term Care	3.4
Incidence of End-Stage Kidney Disease (ESKD), by Age Group, Sex, Province, Rate per Million Population	4.1
Incidence of End-Stage Kidney Disease (ESKD), by Primary Diagnosis	4.1
Inflow/Outflow Ratio	3.2

Influenza Immunization for Seniors	3.4
In-Hospital Sepsis	3.3
Injury Hospitalization	4.1
Joint Replacement Wait Times	3.1
Knee Replacement Rate (All Types)	2.2
Length of Stay Efficiency	3.5
Life Expectancy at Age 65	4.1
Life Expectancy at Birth	4.1
Low Birth Weight Rate (<2,500 Grams, Excluding <500 Grams)	4.1
Low-Risk Caesarean Sections	3.4
Medical Patients Readmitted to Hospital	3.4
Mental Health General Hospital Inpatient Separations as a Percentage (Pan-Canadian) of All General Hospital Inpatient Separations, by Province, Diagnosis Category, Sex and/or Age Group	2.2
Mental Illness Hospitalization	3.2
Mental Illness Patient Days	3.2
Midwives per 100,000 Population	2.2
Obesity	1.2
Obstetric Patients Readmitted to Hospital	3.4
Obstetric Trauma (With Instrument)	3.3
Pan-Canadian Age-Standardized (or Crude) Mental Illness Separations per 100,000 Population, by Province and/or Region	2.2
Pan-Canadian Percentage of Total Days Stayed in General Hospitals for Mental Illness, by Province, Diagnosis Category, Sex and/or Age Group	2.2
Patient Flow for Hip Replacement	3.2
Patients 19 and Younger Readmitted to Hospital	3.4
Perceived Health	4.1
Percentage of Claims Accepted by Public Drug Programs for Generic Drugs	2.3
Percentage of Prescribed Drug Spending Financed by Public Sector	2.2
Percentage of Public Drug Program Spending on Generic Drugs	2.3
Percentage of Residents Who Had a Newly Occurring Stage 2 to 4 Pressure Ulcer	3.3
Percentage of Residents Whose Behavioural Symptoms Improved	3.4
Percentage of Residents Whose Behavioural Symptoms Worsened	3.4
Percentage of Residents Whose Bladder Continence Worsened	3.4
Percentage of Seniors on Public Drug Programs With Accepted Claims	2.5
Percentage Rate of Chronic Beers Drug Use Among Seniors on Public Drug Programs	3.4
Percutaneous Coronary Intervention Rate	2.2
Physical Activity During Leisure Time	1.2
Physicians per 100,000 Population, by Specialty	2.2
Potentially Inappropriate Medication Prescribed to Seniors	3.4
Potentially Inappropriate Use of Antipsychotics in Long-Term Care	3.2
Prescribed Drug Spending per Capita	2.2
Proportion of Physicians in Rural Areas	2.2
Radiation Treatment Wait Times	3.1
Repeat Hospital Stays for Mental Illness	3.2
Restraint Use in Long-Term Care	3.2
Self-Injury Hospitalization	4.1
Small for Gestational Age Rate	4.1
Smoking	1.2
Specialist Wait Times	3.1

Surgical Patients Readmitted to Hospital	3.4
Time in Emergency Department Until Disposition Decision	3.1
Total Time Spent in Emergency Department	3.1
Total Time Spent in Emergency Department (Admitted Patients)	3.1
Total Time Spent in Emergency Department (Non-Admitted Patients)	3.1
Transplants, by Organ Type	2.2
Wait Times for Bypass Surgery	3.1
Wait Times for Cataract Surgery (Percentage Meeting Benchmark)	3.1
Wait Times for Cataract Surgery (Percentiles)	3.1
Wait Times for CT Scan	3.1
Wait Times for Hip Fracture Repair: From ED Registration (Percentage Meeting Benchmark)	3.1
Wait Times for Hip Fracture Repair: From ED Registration (Percentiles)	3.1
Wait Times for Hip Fracture Repair: From Inpatient Admission (Percentage Meeting Benchmark)	3.1
Wait Times for Hip Fracture Repair: From Inpatient Admission (Percentiles)	3.1
Wait Times for Hip Replacement (Percentage Meeting Benchmark)	3.1
Wait Times for Hip Replacement (Percentiles)	3.1
Wait Times for Knee Replacement (Percentage Meeting Benchmark)	3.1
Wait Times for Knee Replacement (Percentiles)	3.1
Wait Times for MRI Scan	3.1
Wait Times for Radiation Therapy (Percentiles)	3.1
Worsened Depressive Mood in Long-Term Care	3.4
Worsened Physical Functioning in Long-Term Care	3.4
Worsened Pressure Ulcer in Long-Term Care	3.3

Select one or more categories of interest to refine indicator list Hide Window

Health System Performance (HSP) Framework

1. Social Determinants of Health

1.1 - Structural factors influencing health

1.2 - Biological, material, psychosocial and behavioural factors

2. Health System Inputs and Characteristics

2.1 - Leadership and governance

2.2 - Health system resources

2.3 - Efficient allocation of resources

2.4 - Adjustment to population health needs

2.5 - Health system innovation and learning capacity

3. Health System Outputs

3.1 - Access to comprehensive, high-quality health services

3.2 - Person-centred

3.3 - Safe

3.4 - Appropriate and effective

3.5 - Efficiently delivered

Areas of Need

A - Staying Healthy

B - Getting Better

C - Living With Illness, Disability or Reduced Function

D - Coping With End of Life

4. Health System Outcomes

4.1 - Improve health status of Canadians

4.2 - Improve health system responsiveness

4.3 - Improve value for money

Refine

Source: CIHI Indicator Library

(<http://indicatorlibrary.cihi.ca/display/HSPIL/Indicator+Library?desktop=true>)

Appendix D: The 12 Public Reporting Performance Measures in Alberta

1. Age-standardized potential years of life lost (PYLL) under age 75, all causes (per 100,000 population).
2. Age-standardized mortality rates from treatable causes (per 100,000 population).
3. Five year relative survival ratios for the top four most common cancers.
4. Access to surgery: percentage of the population reporting wait time of four months or more for elective surgery.
5. Harmful incident indicator.
6. Patient satisfaction with quality of health care services received.
7. Access to primary health care: percentage of the population with a regular medical doctor.
8. Acute care hospital admission rate for ambulatory care sensitive conditions (per 100,000 population).
9. Thirty-day unplanned readmission rates to acute care facilities: all causes.
10. Age-sex standardized hospitalization rate (per 100,000 population).
11. Per capita provincial government health expenditures.
12. Cost per weighted case.

Data as of 2013.

Source: Alberta Health Services Health System Outcomes and Measurement Framework (AHS, 2013)

Appendix E: The 25 Public Health Performance Measures in BC

- **Goal 1: Health living & health communities:** Supportive communities that make it easier for people to make healthy choices at every stage of life.
 - **Measure 1:** Proportion of British Columbians (age 12+) who consume at least 5 servings of fruit and vegetables per day. *[2009/10 baseline: 44%; 2023 target: 55%]*
 - **Measure 2:** Percent of British Columbians who are meeting the guidelines for physical activity. *[2009/10 baseline: 60%; 2023 target: 70%]*
 - **Measure 3:** Percent of British Columbians (age 15+) who smoke. *[2010/11 baseline: 14%; 2023 target: 10%]*
 - **Measure 4:** Percent of BC students in grades 3, 4, 7, 10 and 12 who report that at school, they are learning how to stay healthy. *[2010/11 baseline: 50%; 2023 target: 90%]*
- **Goal 2: Maternal, child & family health:** Families have the capacity to achieve and maintain good health at all stages of child development.
 - **Measure 5:** Rate of low weight singleton births (per 1,000). *[2008-10 baseline: 41; 2023 target: 36]*
 - **Measure 6:** Percent of new mothers who report smoking during pregnancy. *[2010/11 baseline: 8.6%; 2023 target: 4%]*
 - **Measure 7:** Rate of hazardous drinking among women of reproductive age. *[No current baseline; 2023 target: 10% reduction]*
 - **Measure 8:** Percent of children who are not vulnerable on any Early Development Indicator Dimensions. *[2010/11 baseline: 69%; 2023 target: 79%]*
- **Goal 3: Positive mental health & prevention of substance harms:** Optimal mental health and reduced harms associated with substances.
 - **Measure 9:** Percent of British Columbians who experience positive mental health. *[2009/10 baseline: 71%; 2023 target: 80%]*
 - **Measure 10:** Percent of young BC children who are not vulnerable in terms of social development. *[2010/11 baseline: 85.5%; 2023 target: 88%]*

- **Measure 11:** Percent of young BC children who are not vulnerable in terms of emotional development. [2010/11 baseline: 86.2%; 2023 target: 88%]
- **Measure 12:** Among BC students who use alcohol or cannabis, the percent who first use before the age of 15. [2008/09 baseline: Alcohol: 75%, Cannabis: 67%; 2023 target: Alcohol: 60%, Cannabis: 55%]
- **Measure 13:** Proportion of British Columbians (age 15+) who engage in hazardous drinking. [2009/10 baseline: 17%; 2023 target: 14%]
- **Goal 4: Communicable disease prevention:** People living longer, higher quality lives free of preventable disease.
 - **Measure 14:** Immunization coverage rates up-to-date by second birthday in accordance with the routine childhood immunization schedule. [2012 baseline: 70%; 2023 target: 90%]
 - **Measure 15:** Incidence of hepatitis C among repeat testers per year (per 1,000). [2007 baseline: 6; 2023 target: 3]
 - **Measure 16:** Percent of newly diagnosed HIV cases with CD4 at diagnosis >500. [2011 baseline: 39%; 2023 target: 75%]
 - **Measure 17:** Condom use among sexually active adolescents. [2008 baseline: 66%; 2023 target: 76%]
 - **Measure 18:** Percent of young women (ages 18-24) who have had a test for chlamydia in the previous year. [2011 baseline: 33%; 2023 target: 40%]
- **Goal 5: Injury prevention:** A safer province that reduces the risk of preventable injuries.
 - **Measure 19:** Age-standardized hospitalization rate for unintentional injuries (per 1,000). [2010/11 baseline: 7.8; 2023 target: 6.2]
 - **Measure 20:** Age-standardized mortality rate for unintentional injuries (per 100,000). [2010 baseline: 20; 2023 target: 15]
 - **Measure 21:** Age-standardized rate of fall-related hospitalizations for British Columbians age 75+ (per 1,000). [2009 baseline: 30.8; 2023 target: 25]
- **Goal 6: Environmental Health:** Environments that optimize and support good health.
 - **Measure 22:** Shigatoxigenic E. Coli rate (per 100,000). [2009-2011 baseline: 2.8; 2023 target: 2]

- **Measure 23:** Listeriosis rate (per 100,000). [2009-2011 baseline: 0.3; 2023 target: 0.2]
- **Measure 22:** Salmonellosis rate (per 100,000). [2009-2011 baseline: 23.1; 2023 target: 19]
- **Measure 23:** Percent of households reporting that they boiled their drinking water during the previous 12 months as a result of boil water orders. [2009 baseline: 12%; 2023 target: 9%]
- **Measure 23:** Percent of persons residing in licensed community care facilities rated as low risk, based on inspections by health authority licensing officers. [No baseline and target have been determined]
- **Goal 7: Public health emergency management:** Communities resilient to health emergencies.
 - **Measure 24:** Number of health authorities (including the First Nations Health Authority) with a pandemic influenza response plan that aligns with the Ministry plan. [2012 baseline: 1; 2023 target: 7]
 - **Measure 25:** Number of health authorities (including the First Nations Health Authority) that have participated in an emergency exercise with a public health component in the last two years. [2012 baseline: 5; 2023 target: 7] (BC Ministry of Health, 2013b)

Source: BC Guiding Framework for Public Health (BC Ministry of Health, 2013b)

Appendix F: Taxpayer Accountability Principles in BC

Taxpayer accountability principles	
1 Cost consciousness (Efficiency)	Strengthen cost management capabilities and foster a culture of cost-consciousness at all levels of public sector organizations. Provide public services and programs as efficiently and effectively as possible to “bend the cost curve” and support sustainable public policies and programs as a lasting legacy for generations to come.
2 Accountability	Transparently manage responsibilities according to a set of common public sector principles in the best interest of the citizens of the province. By enhancing organizational efficiency and effectiveness in the planning, reporting and decision making, public sector organizations will ensure actions are aligned with government’s strategic mandate.
3 Appropriate Compensation	Comply with a rigorous, standardized approach to performance management and employee compensation, which reflects appropriate compensation for work across the public sector that is consistent with government’s taxpayer accountability principles and respectful of the taxpayer.
4 Service	Maintain a clear focus on positive outcomes for citizens of British Columbia by delivering cost-efficient, effective, value-for-money public services and programs.
5 Respect	Engage in equitable, compassionate, respectful and effective communications that ensure all parties are properly informed or consulted on actions, decisions and public communications in a timely manner. Proactively collaborate in a spirit of partnership that respects the use of taxpayers’ monies.
6 Integrity	Make decisions and take actions that are transparent, ethical and free from conflict of interest. Require the establishment of a strong ethical code of conduct for all employees and executives. Serve the citizens of British Columbia by respecting the shared public trust and acting in accordance with the taxpayer accountability principles.

Source: *Taxpayer Accountability Principles (BC Government, 2014)*

Appendix G: Public Reporting Performance Measures from BC Health Authorities

Vancouver Island Health Authority

Quality and Patient Safety

1. Ambulatory Care Sensitive Conditions (ACSC).
2. Care Sensitive Adverse Events.
3. Clostridium Difficile Rates.
4. Emergency Department Patient Experience.
5. Falls with Injury in Residential Care.
6. Hand Hygiene Compliance.
7. Hospital Standardized Mortality (HSMR).
8. Readmission Rate.
9. Surgical Safety Checklist.
10. Surgical Site Infections.

Patient Flow

11. Access to Acute Rehab Beds.
12. Acute Care Occupancy.
13. Acute Length of Stay.
14. Alternate Level of Care (ALC).
15. Emergency Admissions Placed.
16. Non-admitted Emergency Visits.
17. Residential Care Admissions from Hospital.

Wait times

18. Cataract Surgery Wait Times.
19. Computed Tomography (CT) Scan Wait Times.
20. Elective Surgeries Meeting Benchmark.
21. Magnetic Resonance Imaging (MRI) Wait Times.
22. Surgical Wait Time – Hip & Knee Replacement.
23. Surgical Wait Time – Hip Fracture Surgery.
24. Wait Times Medical Detox.
25. Wait Times for Home Care Services.

Work Life

26. Staff Sick Time Rate.
27. Staff Overtime Rate.

28. Time Loss Injury Rate.
29. Short Term Disability Duration.
30. Long Term Disability Claims.

Finance

- Financial measures are outlined in Island Health's financial reports and focus on financial assets, liabilities, non-financial assets, expenses, revenues, cash flows, and more.

Patient care model monitoring

- These measures are used to monitor the implementations and impacts of the new patient care model at Nanaimo Regional General Hospital, Victoria General Hospital, and Royal Jubilee Hospital. Four performance indicators are used at each hospital: Patient Experience, Health Outcomes, Patient Care Documentation, and Workforce Sustainability.

Source: Vancouver Island Health Authority Public Reporting Performance Measures (VIHA, 2014)

Island Health Performance Measures

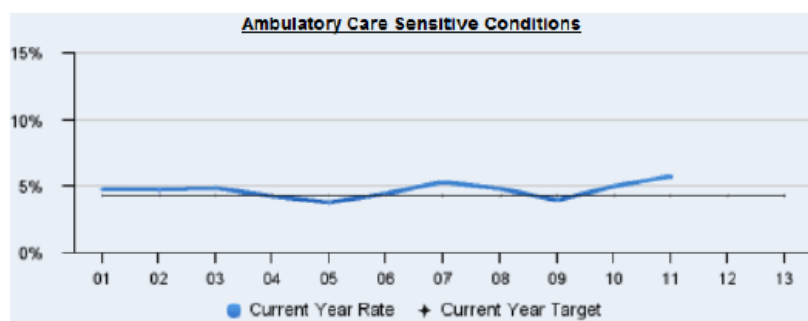
Ambulatory Care Sensitive Conditions



Monitor and take appropriate action

2013/14 Island Health Target: $\leq 4.3\%$

Year to Date: **4.7%**



What do we measure and why?

This indicator measures the rate of acute care (hospital) discharges of patients under 75 years who have a medical condition that could be managed in a non-hospital (ambulatory) setting. These conditions include epilepsy, chronic obstructive pulmonary disease (COPD), asthma, diabetes, heart failure, hypertension and angina.

The Ambulatory Care Sensitive Conditions (ACSC) rate is the percentage of patients under 75 who are discharged with these conditions as a proportion of all discharged patients in this age group.

The rate is important because it can indicate appropriate access, or barriers to access, to effective and appropriate community and primary care, which may prevent or reduce the need for hospital admission.

What is the target?

Island Health's internal target is a rate of 4.3% or less.

How are we doing?

Island Health is not meeting the target. Our ACSC rate as of the end of January 2014 is 4.7%, above the target of 4.3%. This rate has shown a worsening trend in recent periods. Variation by site is noticeable, with Royal Jubilee Hospital and Victoria General Hospital being the only two Island Health sites to achieve the target in both 2012/13 and 2013/14 (year to date).

What actions are we taking?

Working with the Division of Family Practice and specialists in Nanaimo, Island Health is developing and implementing a pathway for caring for patients with heart failure. In addition, Telehome Monitoring for patients with heart failure has been implemented in Victoria and Nanaimo/Oceanside.

What you can do:

Island Health residents can achieve good health and wellness through diet, exercise and other lifestyle approaches. Once diagnosed with a chronic medical condition, patients should follow instructions from their health care provider on how to best manage their condition.

Data date: January 2014 Published: June 2014
http://www.viha.ca/about_viha/accountability

One-page Information on Island Health's ACSC Measure (VIHA, 2014)

Vancouver Coastal Health Authority

Goal 1: Provide the best care

- System level.
 1. Emergency department patient experience.
 2. HSMR.
- Reduce unnecessary variation in care by using evidence based protocols.
 3. Clostridium difficile infection rate.
 4. Hand hygiene compliance.
- Improve clinical integration and quality by building regional programs, departments and processes.
 5. Surgery wait time.
 6. Unplanned readmission rate to hospital.
- Build an integrated electronic health record.
 7. Electronic health record adoption rate.

Goal 2: Promote better health for communities

- System level.
 8. Measles, mumps and rubella (MMR) immunization coverage rates.
 9. ALC days.
 10. Percent of communities that have completed healthy living strategic plans.
- Implement targeted health promotion and prevention initiatives to reduce the incidence of chronic disease.
 11. Early childhood development index.
 12. Overweight or obesity rate.
- Reduce health inequities in the populations we serve.
 13. Disparity ratio for life expectancy.
- Coordinate care across the continuum of primary, community, home and acute care.
 14. ACSC rate (<75 years).
 15. Age standardized home health rate (>75 years).

Goal 3: Develop the best workforce

- System level.

16. Staff safety scores.
17. Employee engagement.
- Maximize staff potential so they can do their best every day.
 18. Sick time rate.
 19. Overtime rate.
 20. Nursing overtime hours.

Goal 4: Innovate for sustainability

- System level.
 21. Research productivity (in millions of dollars).
 22. Average cost of a hospital stay.
- Optimize capacity, resource utilization and productivity.
 23. Acute productive hours per patient day.
- Do the most with the least environmental impact.
 24. Food tray waste

Source: Vancouver Coastal Health Authority Public Reporting Performance Measures (VCHA, 2014).

Surgery Wait Time Longer Than 52 Weeks

How many patients have long waits for non-emergency surgeries?

What are we measuring?

We measure the percentage of patients waiting longer than one year, or 52 weeks, for elective surgery from the date their surgeon submits the booking package to one of our hospitals.

Why?

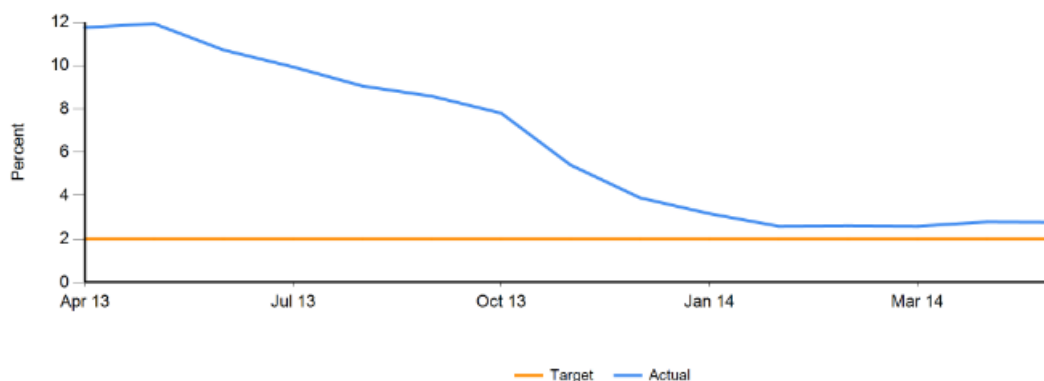
Our goal is to provide the best care for our patients. Elective surgery can be scheduled in advance because it does not involve a medical emergency, but we want to meet or exceed the Ministry of Health's target that no patient should wait more than one year for surgery.

How do we measure it?

We track the date hospitals receive the booking package from the surgeon's office to the date the patient has the surgery. We take the number of patients waiting longer than 52 weeks and divide it by the total number of patients on the waiting list. As of November 18, 2013 Colonoscopy and Gastroscopy cases are excluded from this report. All results from FY2013/14 onwards are recalculated.

How are we doing?

The number of patients in the Surgical Patient Registry waiting over 52 weeks has been reduced from just over 2000 patients one year ago to approximately 400 patients or 2.8%. A Lower Mainland plan is underway to address a long-standing issue for sino-nasal patients. Furthermore, all booking offices have built in sustainable wait list management practices, and work closely with the other surgeons who continue to have long waiting patients.



What we are doing?

1. We are providing surgeon offices with regular reports that show which patients are waiting the longest. This makes it easier for them to book patients according to the wait time target. 2. We are giving extra OR time to surgeons to specifically treat patients who have been waiting more than one year and bringing in additional surgeons to help treat the patients of those surgeons with the highest number of patients waiting more than one year. 3. We are looking at the referral patterns for the surgeons with the longest waits, and will be working with Fraser Health to develop criteria for referral for secondary & tertiary surgery.

What can you do?

1. Use the B.C. Ministry of Health Surgical Wait Times website, at www.health.gov.bc.ca/swt, to look at the typical waiting times for surgeons performing your surgery. Talk to your family doctor about seeing a surgeon with a shorter wait time. 2. Let your surgeon know if you're not yet ready, willing and able to have surgery. 3. Let your surgeon know if you're going to be temporarily away or unavailable for surgery because of vacation or other personal reasons.

Our performance	Target *
2.8 %	<= 2.0 %
of patients waiting longer than 52 weeks for elective surgery	

Year-to-date Timeline: Apr 2014 to May 2014

*Our target is set by the BC Ministry of Health

One-page Information on VCHA's Surgery Wait Time Measure (VCHA, 2014)

Fraser Health Authority

The Fraser Health Authority Service Plan contains five performance measures categorized under the provincial goals and objectives stated in the Ministry's health system strategy:

Goal 1: Support the health and wellbeing of British Columbians.

- Objective 1.1: Implement targeted and effective primary prevention and health promotion.
 - ***Performance Measure 1:*** Percent of communities that have completed healthy living strategic plans.

Goal 2: Deliver a system of responsive and effective health care services across BC.

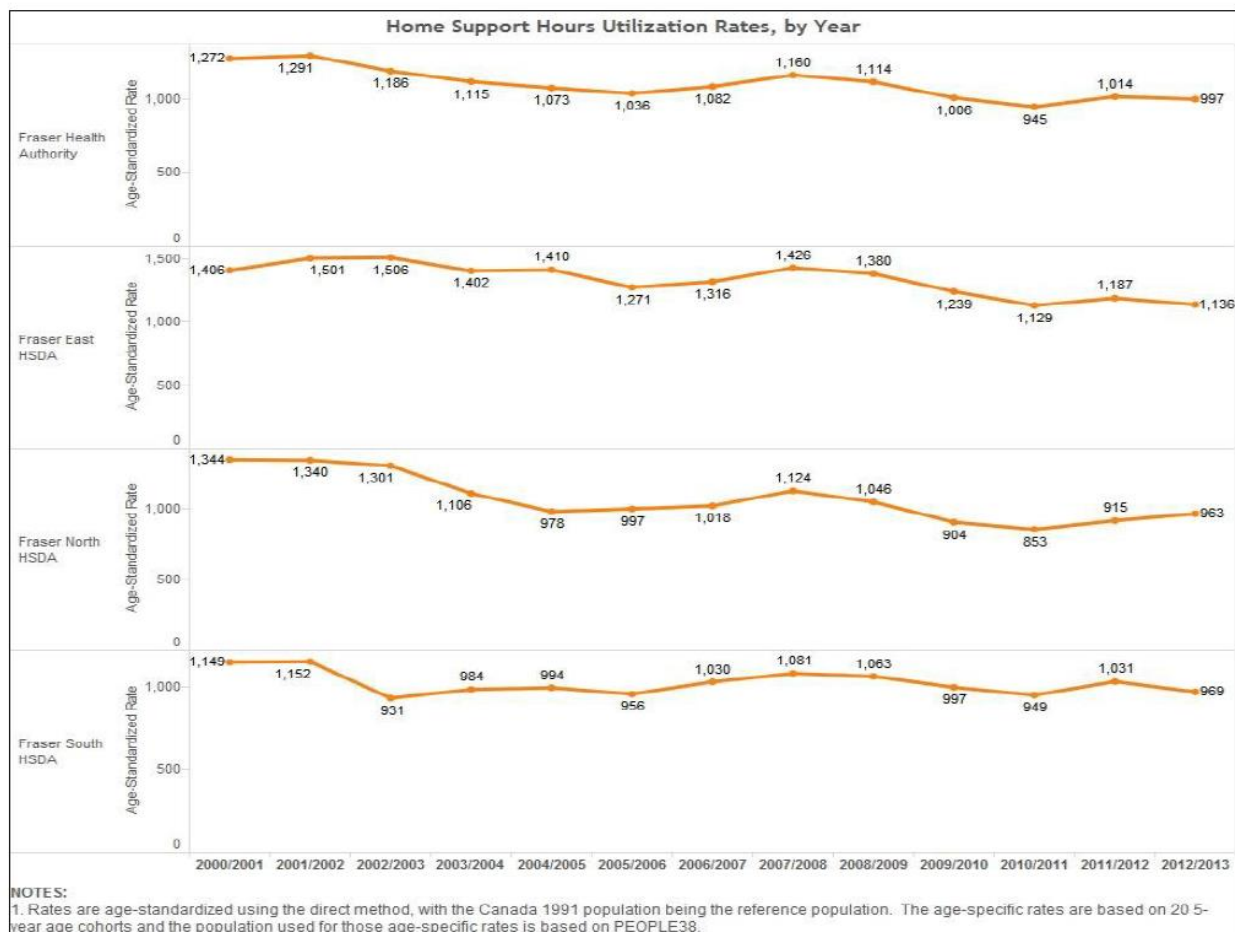
- Objective 2.1: Strengthen commitments to patient-centred care.
- Objective 2.2: Strengthen the system of primary and community care built around inter-professional teams, processes and functions to better prevent and manage chronic conditions.
 - ***Performance Measure 2:*** Managing chronic disease in the community.
 - ***Performance Measure 3:*** Home health care and support for seniors.
- Objective 2.3: Strengthened interface between primary and specialist care and treatment.
- Objective 2.4: Provide timely access to quality diagnostics.
- Objective 2.5: Renewed role of hospital in the regional health care continuum.
 - ***Performance Measure 4:*** Access to surgery.
- Objective 2.6: Increased access to an appropriate continuum of residential care services.

Goal 3: Ensure value for money.

- Objective 3.1: Evidence-informed access to clinically effective and cost-effective pharmaceuticals.
- Objective 3.2: Align workforce, infrastructure, information management, and technology resources to achieve patient and service outcomes.
 - ***Performance Measure 5:*** Nursing overtime.
- Objective 3.3: Drive budget management, efficiency, collaboration, and quality improvement to ensure sustainability of the publicly funded health system.

Source: Fraser Health Authority Strategic and Operational Plan 2014/15 – 2016/17 (FHA, 2014b)

Home Support Utilization rate Over 10 years.



FHA's Home Support Utilization Rate Performance Measure (FHA, 2014a)

Interior Health Authority

Interior Health Authority's performance measures grouping in its goals and objectives are:

Goal 1: Improve health and wellness: Enable people to live healthier lives by working at the environmental, policy, community and individual levels to protect the health of the population and reduce health inequities.

- **Performance Measure 1:** Percent of communities that have completed healthy living strategic plans.

Goal 2: Deliver high quality care: Provide care that is accessible, safe, effective, evidence informed, and delivered in the most appropriate setting.

- **Performance Measure 2:** Number of people with a chronic disease admitted to hospital (per 100,000 people aged less than 75 years).
- **Performance Measure 3:** Percent of people aged 75+ receiving home health care and support.
- **Performance Measure 4:** Percent of non-emergency surgeries completed within the benchmark wait time.

Goal 3: Ensure sustainable health care by improving innovation, productivity, and efficiency:

Promote new ways of working to provide better service and reduce costs.

Goal 4: Cultivate an engaged workforce and a healthy workplace: Enhance working relationships and advance practices in the workplace that address health and safety issues.

- **Performance Measure 5:** Nursing overtime hours as a percent of productive nursing hours.

Source: Interior Health Authority 2013/14 – 2015/16 Service Plan (IHA, 2013)

Northern Health Authority

Northern Health Authority's strategic goals and corresponding performance measures are:

Goal 1: A population health approach.

- **Performance Measure 1:** Percent of communities that have completed health living strategic plans.

Goal 2: Integrated accessible health services.

- **Performance Measure 2:** Number of people with a chronic disease admitted to a hospital (per 100,000 people aged less than 75 years).
- **Performance Measure 3:** Home health care and support for seniors.

Goal 3: High-quality services.

- **Performance Measure 4:** Percent of non-emergency surgeries completed within the benchmark wait time.

Goal 4: A focus on people in the NHA.

- **Performance Measure 5:** Nursing overtime hours as a percent of productive nursing hours.

Source: Northern Health 2013/14 – 2015/16 Service Plan (NHA, 2013).

Provincial Health Service Authority

Aiming to report performance for the three PHSA corporate strategic directions as well as Ministry's goals and objectives, PHSA's six performance measures are:

- **Performance Measure 1:** Percent of women aged 50-69 years participating in screening mammography once every two years.
- **Performance Measure 2:** Percent of dialysis patients on independent dialysis modalities (peritoneal dialysis & home haemodialysis).
- **Performance Measure 3:** Percent of children admitted to an inpatient psychiatric unit bed within 42 days.
- **Performance Measure 4:** Percent of non-emergency complex paediatric hip surgery completed within established benchmarks.
- **Performance Measure 5:** Percent of women with previous C-section births who plan to have a vaginal delivery.
- **Performance Measure 6:** Nursing overtime hours as a percent of productive nursing hours.

Source: PHSA Service Plan 2013/14 – 2015/16 (PHSA, 2013).

Strategic Direction #1: Improving Quality Outcomes and Better Value for Patients
1.1 Provide seamless patient-centered care for populations within our mandate.
1.2 Continue to implement the foundational elements of a Clinical Information Solution (CIS).
1.3 Increase the application of evidence and leading practices.
1.4 Enhance service delivery to provide safe, reliable and efficient care for patients and families.
Strategic Direction #2: Promoting Healthier Populations
2.1 Improve childhood development.
2.2 Promote health in high risk populations.
2.3 Help people living with chronic disease maintain independence and stay as healthy as possible.
Strategic Direction #3: Contributing to a Sustainable Health Care System
3.1 Achieve economies of scale and greater integration within PHSA and with our partners.
3.2 Optimize the use of our scarce resources and align them with the programs / services that provide best value to the people we serve.
3.3 Leverage our clinical services and research expertise to generate revenue or added value.

PHSA's Strategic Directions and Objectives 2010-2013 (PHSA, 2010)

Appendix H: Jay W. Forrester's World Dynamics Model

Structure of the World System 21

20 Chapter Two

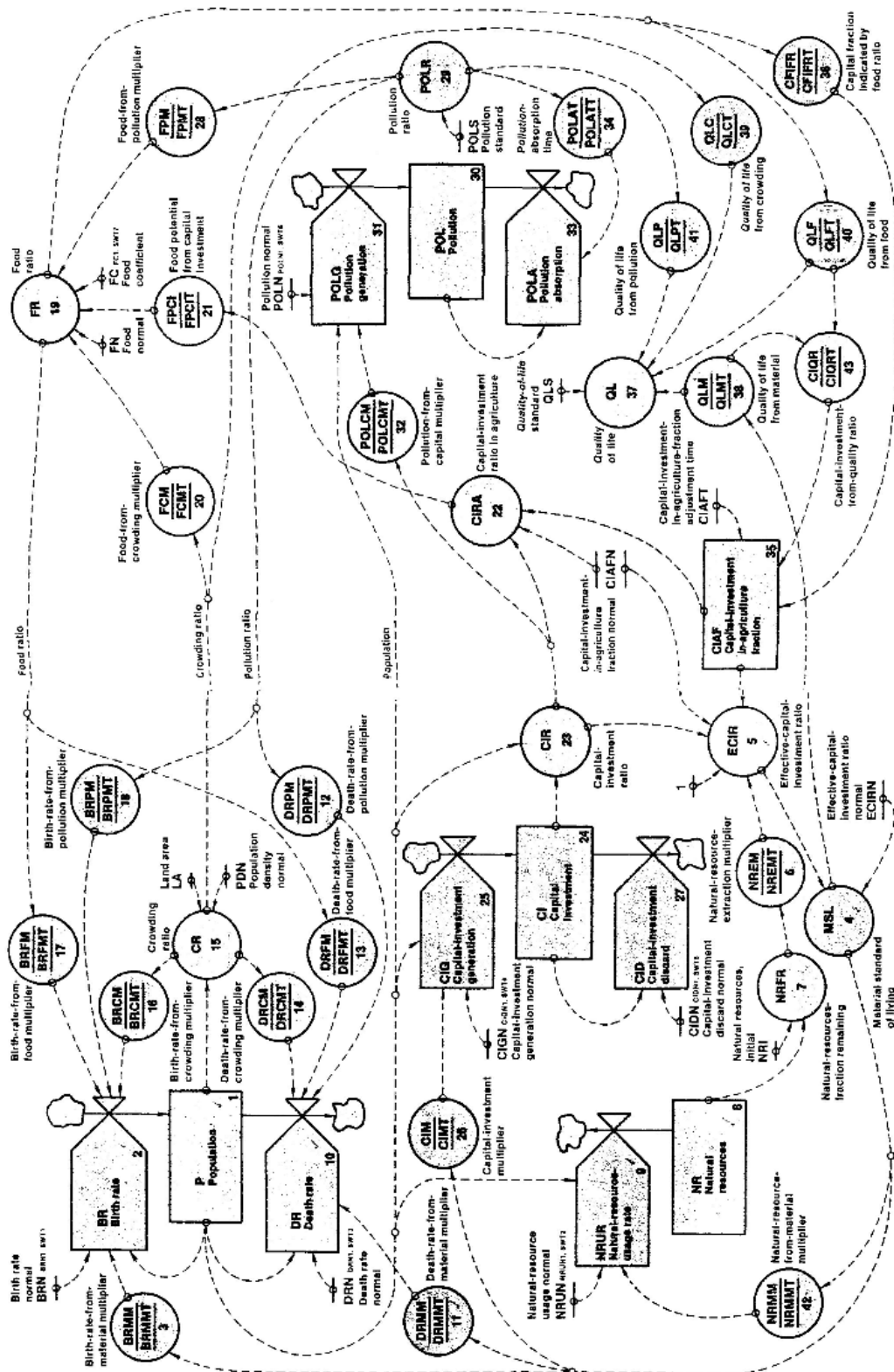


Figure 2-1 Complete diagram of the world model interrelating the five level variables — population, natural resources, capital investment, capital investment-in-agriculture fraction, and pollution.

Source: World Dynamics. (Forrester, 1971)

Appendix I: A Stepwise Method for Qualitative System Dynamics

Phase One – Problem Exploration / Model Creation

- Step 1: Recognise the key variables associated with the perceived cause(s) for concern. Where possible, obtain data on the behaviour of these variables over time and define a reference mode for the existing system behaviour over a suitable time horizon.
- Step 2: Identify some of the initial system resources associated with the key variables.
- Step 3: Identify some of the initial states (levels) of each resource. These initial states should be defined at a reasonably high level of aggregation.
- Step 4: Construct resource flows for each resource, containing the identified states and their associated rates of conversion. Include any significant process delays in the resource flows. (A resource flow must contain at least one resources state and one rate).
- Step 5: If more than one state of reach resource is involved cascade the resource flows together to produce a chain of resource or transfer, alternating the levels and rates.
- Step 6: Within each resource flow identify organisational boundaries, behavioural information flows and strategies by which the levels influence the rates. Include any significant delays in the information flows.
- Step 7: Identify similar organisational boundaries, behavioural/information flows and strategies between different resource flows. For complex situations this should be carried out for small groups of resources at a time within a defined theme and the resultant diagrams reduced to produce the simplest representation possible, consistent with relating the key variables of the investigation.
- Step 8: Identify any new states of existing resources, or new resources, which affect the variables created and add these to those identified in steps 2 and 3.
- Step 9: Reiterate if necessary.

Phase Two – Model Analysis

- Step 1: Isolate the major feedback loops in the model, whether arising intuitively or from the modular approach to model construction.
- Step 2: Assess the general mode of behaviour of the individual loops and the whole model over time arising from the strategies contained within them. This can be achieved in simple cases by determining the polarity of each feedback loop or in more complex cases, by tracing round each loop the effect of a change in one of its constituent rate variables. Check if this mode of behaviour is consistent with any reference mode available for the system.
- Step 3: Identify the rate variables within each loop which are available to be controlled, that is, those which are within the boundaries of the organisation trying to implement the system control.

Step 4: Identify, possible ways to control these variables. For example, by defining target states for them or by linking them to information sources (levels) elsewhere in the model and specifying appropriate strategies by which to use the information.

Step 5: Assess, as in step 2, the general model of behaviour of the model arising from any new feedback loops created in step 4.

Step 6: Reiterate from step 3, if necessary.

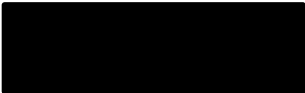
Source: Wolstenholme, 1985, 1990

Appendix J: Certificate of Approval



Human Research Ethics Board
 Office of Research Services
 Administrative Services Building
 PO Box 1700 STN CSC
 Victoria British Columbia V8W 2Y2 Canada
 Tel 250-472-4545, Fax 250-721-8960
 Email ethics@uvic.ca Web www.research.uvic.ca

Certificate of Approval

PRINCIPAL INVESTIGATOR: William Yang	ETHICS PROTOCOL NUMBER 14-451
UVic STATUS: Master's Student	Minimal Risk - Delegated
UVic DEPARTMENT: HEIS	ORIGINAL APPROVAL DATE: 11-Feb-15
SUPERVISOR: Dr. Abdul Roudsari	APPROVED ON: 11-Feb-15
	APPROVAL EXPIRY DATE: 10-Feb-16
PROJECT TITLE: Applying qualitative system dynamics to enhance performance measurement for a sustainable health system in British Columbia	
RESEARCH TEAM MEMBERS None	
DECLARED PROJECT FUNDING: None	
CONDITIONS OF APPROVAL	
<p>This Certificate of Approval is valid for the above term provided there is no change in the protocol.</p> <p>Modifications To make any changes to the approved research procedures in your study, please submit a "Request for Modification" form. You must receive ethics approval before proceeding with your modified protocol.</p> <p>Renewals Your ethics approval must be current for the period during which you are recruiting participants or collecting data. To renew your protocol, please submit a "Request for Renewal" form before the expiry date on your certificate. You will be sent an emailed reminder prompting you to renew your protocol about six weeks before your expiry date.</p> <p>Project Closures When you have completed all data collection activities and will have no further contact with participants, please notify the Human Research Ethics Board by submitting a "Notice of Project Completion" form.</p>	
Certification	
<p>This certifies that the UVic Human Research Ethics Board has examined this research protocol and concluded that, in all respects, the proposed research meets the appropriate standards of ethics as outlined by the University of Victoria Research Regulations Involving Human Participants.</p> <div style="text-align: center;">  <hr/> <p>Dr. Rachael Scarth Associate Vice-President Research Operations</p> </div>	

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Certificate Issued On: 11-Feb-15

Appendix K: Interview Questions

Purpose validation

1. Is the purpose of the proposed system dynamics performance measurement system model clear to you?

Structure validation

2. Is the proposed model structure consistent with the structure of the Health Quality Matrix proposed by the BC Patient Safety & Quality Council?

Boundary validation

3. Can you see the BC health system boundary in the model?
4. Are the salient dimensions for addressing health system sustainability reflected in the model?

Variables validation

5. Are internal and external health system variables demonstrated in the model?
6. Are the causal relationships among the variables clear to you?
7. Do you see any relevant health system components for measuring the performance of BC health system that are not included in the model?
8. Are there other performance measures for the identified performance dimensions related to quality and/or sustainability missing from this model?

Pragmatics validation

9. Can you see how the BC Health System Matrix data can be applied in the proposed model to measure, monitor, and report on the performance of the BC health system? Are there other BC health and social data that you see suitable for the proposed model?
10. Do you agree that the proposed qualitative system dynamics approach to performance measurement in this research could improve the performance measurement and quality improvement for sustainable health service delivery in BC? If so, how so? If not, what would you recommend?

Appendix L: Interview Responses from All Fifteen Participants

Purpose validation

1. Is the purpose of the proposed system dynamics performance measurement system model clear to you?
 - Participant 1: Yes, knowing the relationships among the variables helps to know the purpose of the model.
 - Participant 2: Yes.
 - Participant 3: Yes, for the most part.
 - Participant 4: Yes.
 - Participant 5: Yes.
 - Participant 6: Yes.
 - Participant 7: Yes.
 - Participant 8: Yes.
 - Participant 9: Yes.
 - Participant 10: Yes.
 - Participant 11: Yes, it is clear because the model identifies policy levers to increase system sustainability.
 - Participant 12: Yes.
 - Participant 13: Yes.
 - Participant 14: Yes.
 - Participant 15: Yes.

Structure validation

2. Is the proposed model structure consistent with the structure of the Health Quality Matrix proposed by the BC Patient Safety & Quality Council?
 - Participant 1: Yes, the HQM components (e.g. accessibility, safety, etc.) are there, but you need other components there as well, like goals, paradigms, and fundamental changes.
 - Participant 2: Yes, but efficiency and equity dimensions were not reflected.
 - Participant 3: Yes, it appears to be.
 - Participant 4: Yes, but equity and efficiency domains are important to include. Consider efficiency impacting occupancy rate. Consider including drugs and effects of drugs. For example, some atypical anti-psychotic drugs will cause weight gain and new diabetes. These can be categorized under Treatment-caused Problems. Another point to consider once this carries to a quantitative analysis: transition between areas of care → patient transit between primary to acute (wait time) and from acute back to primary (e-prescription); we don't do well in managing mental health patients.
 - Participant 5: Yes.

- Participant 6: Yes.
- Participant 7: Yes.
- Participant 8: Yes.
- Participant 9: Yes, because you've pulled in all the factors and dimensions from the BC Health Quality Matrix. They are listed and all matched.
- Participant 10: Yes.
- Participant 11: Yes, this is the best use of the BC Health Quality Matrix I've seen.
- Participant 12: Yes.
- Participant 13: Yes.
- Participant 14: Yes.
- Participant 15: Yes, except yours includes feedback loops.

Boundary validation

3. Can you see the BC health system boundary in the model?

- Participant 1: Yes.
- Participant 2: Yes.
- Participant 3: Yes.
- Participant 4: Yes, some external variables might be able to sit on the border. For example, the Health Education variable.
- Participant 5: Yes.
- Participant 6: Yes.
- Participant 7: Yes.
- Participant 8: Yes.
- Participant 9: Yes.
- Participant 10: Yes.
- Participant 11: Yes.
- Participant 12: Yes.
- Participant 13: Yes.
- Participant 14: Yes.
- Participant 15: Yes.

4. Are the salient dimensions for addressing health system sustainability reflected in the model?

- Participant 1: Yes, however, you need to think deeper. The current model within the health system boundary is more of a medical model or physician-centred model. Need to represent other care components in it as well.
- Participant 2: I can see the relationships you identified that lead to health system sustainability; however, some of them are assumptious. If the relationships are all proven valid, then yes. The danger in modeling is the misinterpretation of the system.

- Participant 3: Yes, however, efficiency and equity dimensions are not being reflected.
- Participant 4: Yes, but the equity dimension of quality is important. The health system should be designed to be equitable to everyone, despite age, gender, and geographical residence.
- Participant 5: Yes.
- Participant 6: Yes.
- Participant 7: Yes.
- Participant 8: Yes.
- Participant 9: Yes, seems like it.
- Participant 10: Yes.
- Participant 11: Yes.
- Participant 12: Economic dimension needs to be included and more prominent. It should be linked to the healthy lifestyle and behaviour variable. If people don't have enough income, they won't pay attention to their health. Healthy foods affordability and accessibility are also important. Stress. Socioeconomic factors.
- Participant 13: Yes.
- Participant 14: Mostly. The dimension of health system structure should be considered.
- Participant 15: Yes.

Variables validation

5. Are internal and external health system variables demonstrated in the model?

- Participant 1: Yes, I think they are. An improvement area would be to redesign the system to make it better.
- Participant 2: Yes, some of both. Not a complete set.
- Participant 3: Yes.
- Participant 4: Yes.
- Participant 5: Yes.
- Participant 6: Yes.
- Participant 7: Yes.
- Participant 8: Yes.
- Participant 9: Yes, however, Safety should include more than infections. Falls, for example, is an example in the Safety dimensions. We need to ensure the right people are included and involved in the care process.
- Participant 10: Yes.
- Participant 11: Yes.
- Participant 12: Yes.
- Participant 13: Yes.
- Participant 14: Yes.
- Participant 15: Yes, these are the key ones.

6. Are the causal relationships among the variables clear to you?
- Participant 1: Some of them are clear, but some of them are not.
 - Participant 2: Yes, relationships are clear, but I have trouble with negative associations.
 - Participant 3: Yes.
 - Participant 4: Yes.
 - Participant 5: Yes.
 - Participant 6: Yes, need to consider the validity of plus and minus (positive and negative) associations.
 - Participant 7: Yes.
 - Participant 8: Yes.
 - Participant 9: Yes, the inclusion of red line to show the main story is good. Excellent explanation. Make sure to describe these causal relationships in the paper.
 - Participant 10: Yes.
 - Participant 11: Yes.
 - Participant 12: Yes.
 - Participant 13: Yes.
 - Participant 14: Yes.
 - Participant 15: Yes.
7. Do you see any relevant health system components for measuring the performance of BC health system that are not included in the model?
- Participant 1: Preventative care is not reflected in the model. Questioning the positive association between Population and Volume of Chronic Conditions variables. If preventative care is working well, then as population grows or stables, the volume of chronic conditions should go down. Also, budget can be linked with the Awareness variable.
 - Participant 2: Yes, the efficiency dimension is not included.
 - Participant 3: No.
 - Participant 4: Affordability of drugs. Adverse events of drugs.
 - Participant 5: Yes.
 - Participant 6: Yes, the proficiency of surgeries and follow-up care after needs to be included. May want to consider “patients’ appropriate use of health care” before they enter care pathways for more of a patient-centred medical model.
 - Participant 7: No.
 - Participant 8: No.
 - Participant 9: Yes, social determinants of health variables and environmental variables. A sample program in BC can be the Breakfast Program for Kids.
 - Participant 10: Yes, patient choice and patient responsibility.

- Participant 11: Yes, IM/IT functions (e.g. innovation, EHRs) are missing. Technology can increase Care Capacity. Also, team-based care. A group of different types of practitioners delivering care together. It's an important distinction and can impact many dimensions of system performance. Also, recruit & retain health professionals. Also, appropriate use of health services.
 - Participant 12: No.
 - Participant 13: Integrated practice unit should be included. Team-based care approach should be reflected in the model. Safety issues from too many tests for patients should be included. Strategic HHR implementation can link to care capacity.
 - Participant 14: Social determinants of health (affordability) can be categorized under the Economic system, which should be included in the model. The Economic system can influence the Health lifestyle and behaviour variable. The environmental factors can influence the Volume of Chronic Conditions variable. This model hasn't included measures on the engagement within the system: health practitioner burnout rate, health workforce injury rates, health worker satisfaction, and productivity. These variables influence innovation and Care Capacity. People within the system have leverage on the operations of the system. Health system resource variables should be included.
 - Participant 15: Social determinants of health are important. Some of them are there. These factors are often underestimated. People are discounting the level of poverty impacting health. Social determinants of health should be linked to the use of health services. Socioeconomic status should be linked with the use of health services. If you are poor and living in a terrible situation, then you tend to use more health services.
8. Are there other performance measures for the identified performance dimensions related to quality and/or sustainability missing from this model?
- Participant 1: Yes, economic measures focusing on finance and income can create stress and further impact population health. Social measures about social norms on diets can be included. Don't know how you would include this one, but the political context has a heavy influence on the health system.
 - Participant 2: Yes, the efficiency measures should be included. One example of the efficiency measures could be: the number of Lean initiatives implemented. Lean initiatives help facilities to cut waste and streamline processes. This can increase the Care Capacity variable. It can also be linked with overall efficiency and quality of the system.
 - Participant 3: Yes, there are many other measures can be included. For example, readmissions from hospitals, and not just from Emergency Department.
 - Participant 4: Equity and efficiency. Cost and effectiveness. Efficacious.
 - Participant 5: No.
 - Participant 6: Yes, appropriateness measures can be expanded. The current model needs to be changed to be less hospital centric.

- Participant 7: Yes, the effectiveness of health resource needs to be included. Having well-trained staff is important. It's not all about quantity, but quality. When staff is better, equipment is better, and drugs and better and more effective, then the internal quality of the health care service is better.
- Participant 8: No.
- Participant 9: Need to include more safety measures than just infections. Injuries are also safety issues.
- Participant 10: For patient choice → treatment options for patients; number of supporting services for different stages of life for British Columbians. Patients should have choices and a variety of care options should be presented to them. Alternative care V.S. Western medical treatments. Patients should also be pro-active; that's the patient responsibility part.
- Participant 11: Types of practitioners assigned to rural community → this reflects on the challenge to fill jobs in rural communities.
- Participant 12: Wait time for care should point back to patient length of stay. Infections should point back to ED readmission.
- Participant 13: Health practitioner education level should be included. This variable can link to Occupancy Rate as an upstream solution. Also, IM/IT solution / innovation should be included, and it influences Care Capacity. IM/IT will also lead to better care, higher quality of care, and more practitioners having access to all patient data. It can be linked to either Care Capacity or Pt Length of Stay.
- Participant 14: Employee engagement scores for care providers. Measurement of patient perceptions of the system: do they have someone who can navigate the system for them? Measures on patient social isolation index. Patient empowerment: establish patient care quality office. On a Venn diagram, Social integration is an overlapped area by the Environmental circle, the Education circle, and the Economic circle. The higher the social integration, the higher the number of informed family/social care givers; hence, the higher the social capacity to support care.
- Participant 15: Falls should be mentioned in the safety domain. Clean and healthy housing: houses in poor conditions are often moldy and leaky. Infections (e.g. TB, gastro-infections), chronic conditions including joint pains are easily formed. Additionally, accessibility and affordability of healthy foods, which are joint measures of socioeconomic and educational dimensions.

Pragmatics validation

9. Can you see how the BC Health System Matrix data can be applied in the proposed model to measure, monitor, and report on the performance of the BC health system? Are there other BC health and social data that you see suitable for the proposed model?

- Participant 1: Yes, socioeconomic status data such as income, education, and food can be included. Social determinants of health data that are associated with the Accessibility domain can be included also.
- Participant 2: Yes.
- Participant 3: Yes, can definitely see the Health System Matrix data being applied in this model. Lots of external data can also be applied here. For example, prevention, education, and awareness data. Tax credits can be included as a sample measure for Reduction of Barriers and Increase of Incentives variables. Bike lanes. Smoking cessation program. Weather conditions. Those measures can be directly linked to the Healthy Lifestyle & Behaviour variable.
- Participant 4: Yes, you could apply HSM data in the model, but many other measures will have to be included. A lot of digging needs to be done. Need to validate assumptions. State those assumptions that are not from the literature and the real world. For example, health education might disengage patients from the public-funded health system. For the quantitative analysis, maybe identify one area of care for the Areas of Care or Population Segments and apply data and see their behaviour throughout the care process. We have equity problems with mental health patients. Their interactions with social and justice systems need to be taken into consideration.
- Participant 5: Yes, I can see how HSM data can be applied in the model. No, for the purpose of this model, the amount of data included in current model will suffice.
- Participant 6: I'm not familiar with the HSM, so can't comment on how HSM data can be applied. However, from hearing your explanations and examples, I agree and can see the benefits of having HSM data applied in the proposed model. Also, PREMs and PROMs data can be helpful for the model to evaluate patient experience and therefore improve care processes.
- Participant 7: Yes, I can see HSM data applied in the model. Other data to include: external benefits/motivation to increase people's awareness to have a healthy lifestyle. Like incentives to stay healthy.
- Participant 8: Yes, I can see HSM data applied in the model. No, I don't see anything else suitable for the proposed model.
- Participant 9: Yes, I can see HSM data applied in the model. Other data to include: environmental factors should be considered.
- Participant 10: Yes, I can see HSM data applied in the model. No, I don't see anything else suitable for the proposed model.
- Participant 11: Yes, I can see HSM data applied in the model. Other data to include: HEABC data for types of practitioners delivering care in BC communities. Rural data (e.g. socioeconomic data) from geographical planning perspectives. RSA communities.
- Participant 12: Yes, I can see HSM data applied in the model. Socioeconomic data such as income, housing, employment, and education data can also be included.

- Participant 13: Yes to the HSM data applicability. As for other data, **more education data can be included**. MCFD and Health are working to develop early year development index and middle year development index. **These EDI (early development instrument) data can be helpful for the model**. **Demographic and geographic data can also be applied**. **Test results from the school to show education proficiencies**.
 - Participant 14: Yes, especially the population segments and data from those cohorts will provide detail-level information on their experience throughout the care pathways. Other data to include are: 1, **Environmental factors such as employment rate, housing affordability data, and rates of welfare use**. Environmental factors can be linked to Volume of Chronic Conditions. 2, **Number of malpractice complaints and/or patient care quality office complaints**. 3, **Better access to EHRs**. 4, **Patients' own self-monitoring devices (e.g. fit bit, fitness apps) can lead to the less reliance from patients on the formal health system; therefore, decrease the use of health services**.
 - Participant 15: Yes, of course they can be applied. This model brings in so many different factors. It pulls together different views to create a more comprehensive explanation of the current system and the current problems the system is facing.
10. Do you agree that the proposed qualitative system dynamics approach to performance measurement in this research could improve the performance measurement and quality improvement for sustainable health service delivery in BC? If so, how so? If not, what would you recommend?
- Participant 1: Yes, **the system managers need to understand causal and feedback relationships among system variables, so this research will be helpful**.
 - Participant 2: Yes, **seeing how the system variables are linked is useful to understand the story**. We need to move away from silos. Use this model and zone in on the Acceptability domain. Additional measures need to be added.
 - Participant 3: Yes, it could. **I see this model can validate and identify extra information for decision makers for identifying policy levers**. **It can also help funding decisions in terms of seeking upstream solutions**. For example, which programs to fund more, and where to take money from? **This model can serve as a new way of identifying relevant external variables. The identification of external variables can help the province to fund critical programs in a sustainable way**.
 - Participant 4: Possibly. This model is a good overview. It seems a bit too high level and it screws the detail. **Details become more important in the quantitative phase and often difficult to implement**.
 - Participant 5: Yes, **this model does a good job linking all performance dimensions and measures. It's great to see patient experience to be included**.
 - Participant 6: Yes, it could definitely support our province.
 - Participant 7: Yes, **using this type of model could really help politicians and executives to decide the best places to allocate or concentrate efforts and resources**.

- Participant 8: Yes, with causal relationships and feedback loops, this model helps us focus on the areas that need more attention such as health education. It is really interesting!
- Participant 9: Yes, I think it can because when things are viewed by fresh eyes with a new methodology, new lessons can be drawn. Such process can improve the current model. Just seeing how delineated the causal relationships are is helpful. It makes us think: this is how it works.
- Participant 10: Yes, I think it can help pinpoint what areas of spending the government could regulate and what areas can be transferred money from. The model helps to find overall weakness of the system.
- Participant 11: Yes, I think you are onto something here. I liked the story you highlighted in the model. Linking together hard and soft variables impacting sustainability is very helpful. Good to see PREMs and PROMs data included. Also interesting to see you include outside variables to show their impact on health system operations.
- Participant 12: Yes, I feel like we don't take nearly as many variables as we should. I think our current performance measurement approach is to pick measures based on what's easy for us to attain and what data we have available. Not necessarily what is the best measures to use. There should be dedicated resources for research and development in performance measurement system development.
- Participant 13: Yes, it's important that we understand the causal relationships and the real areas we can leverage both policy and resource to become sustainable. Not just to save cost, but be sustainable.
- Participant 14: Definitely. The causal feedback loop can help identify better or more appropriate performance measures. The inclusion of PREMs and PROMs measures in this model is a good consideration of feedback measures. Some of the measures in this model are high-level measures. It serves the purpose of viewing the system holistically. It shows good flexibility in identifying intermediate measures by zooming in the high-level causal relationships.
- Participant 15: Yes, I believe it could. It takes "sustained commitment" to plan it out, stick it out and follow through on this. Not try it for a short period of time and then trash it in four years. It needs "sustained commitment." Increase and improve child health care can impact health system operations in 20 years. Long term vision and commitment are needed.

Appendix M: Web of Measures 2.0

