Essays on Mental Health Policy Modeling and Development

By
Zainab Mahdi Almukhtar

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Approved: Dr. Michael Zhang
Supervisor

Approved: Dr. Claver Diallo
Committee Member

Approved: Dr. Jenny Chen
Committee Member

Approved: Dr. Mohamed Drira
Committee Member

Approved: Dr. Yinglei Wang
Examiner

Date:

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Abstract

This study focuses on developing policy guidelines for the improvement of mental health services in Canada. By applying comprehensive approaches, we address prevalent issues in the mental health services such as access to mental healthcare, quality issues, capacity shortages and miscoordinations among mental health services. We developed analytical models to demonstrate the interrelated impacts of gaps in the mental health services in Canada on the performance of the system of mental healthcare. We proposed and validated pathways to solve those issues. In the first essay, we built a model to demonstrate how access issues in the mental health services increase the utilization of emergency departments. We presented solutions to minimize the total cost of the mental health system and manage the number of patients using the emergency departments for mental healthcare considering different contextual conditions. In the second essay, we constructed a framework to design mental health services integrating effectiveness and efficiency. We analyse patients' preferences of the two important attributes of standardization and individualization and investigate how patients' behaviours and characteristics impact the design of mental health services. In the third essay we developed a framework to build capacity and resilience via collaboration of mental health organizations in Nova Scotia. We derive optimal strategies to solve prevalent issues in the mental health system in Canada. By our multifactorial analysis, we incorporate the dynamics of an array of factors in the mental health services including personal, economic and system elements. This research bridges operational and mental health research fields to provide analytical and conceptual outcomes. Throughout our work, we verified the importance of following complementary strategies in designing of and implementing developments to mental health services. Based on the analysis and empirical evidence, the study delivers policy implications and practical roadmaps to improve mental heath services in Canada.

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1. Introduction

1.1 Background

It is estimated that around five million people in Canada need help for mental health issues (MHCC 2017). Half of those people reported unmet or partially met needs[1]. Untreated or insufficiently treated mental health problems have consequences on the individuals, the society, and the economy (Winters et al., 2009; Mental Health Commission of Canada, 2012). Research shows that mental health services in Canada suffer from several interlaced issues such as poor access, lack in capacities, quality issues, resource misallocations, and others. The mentioned issues in the mental health services have become even more predominant during the conditions of COVID 19[2] and the increased demand on healthcare and mental healthcare services (Vaillancourt et al., 2021). The high miscoordination among mental health services complicates those issues (Bartram 2017). Literature underscore the importance of following holistic approaches in researching the mental health services (Kaltenborn et al., 2021). Within that, it is essential to incorporate the complex nature of mental healthcare (Weaver 2022) that is linked to personal, social, economical and cultural factors (Pietrabissa et al., 2022). Related to the same scope, to achieve efficient resource distribution among mental health services, it is important to follow strategic and complementary resource allocation plans (Fleury et al., 2002; Friedli et al., 2009; Mental Health Commission of Canada, 2017). Motivated by all the above, we conducted this study to address

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[1] Mental health care needs, 2018 (statcan.gc.ca)
[2] https://www.kff.org/coronavirus-covid-19/issue-brief/the-implications-of-covid-19-for-mental-health-and-substance-use/

important barriers in the Canadian mental health system and suggest possible solutions to those barriers. Unlike much of the research in mental healthcare, we follow a comprehensive approach in analysing the impacts of issues in the mental health services on the performance of the mental health system such as the impact of poor access and poor-quality decisions on the total cost of the mental health system. Comprehensive approaches to mental healthcare capture the connections between different parts of the mental health services and consider the impacts of malfunctions on different area of the mental health system (USAID, 2017). For example, by following a comprehensive approach, we recognize links between issues in the emergency departments for mental healthcare and access barriers to the mental health service providers. By this we can capture the complexities in the mental healthcare by analysing the interactions of different factors in the mental healthcare system. Based on our analysis, reviews, and empirical evidence we developed plans to improve the mental health services in Canada. Our solutions encompass the dynamics between elements in the mental health services such as patients', economical, social, health related, and structural elements. We further suggest strategies and pathways to implement those solutions. This study offers important insights for policy makers and planners on the sizes and impacts of gaps in the mental health services. The outcomes of the study set directions for logical plans to improve the design and delivery of health and mental health services. The research unlocks new avenues on processes and methods to research healthcare and mental healthcare services in Canada. The conclusions and models can be applied to health and mental health services in different locations after incorporating contextual and structural differences.

1.2 Connection between the essays

The essays in this dissertation tackle various yet interconnected issues in the Canadian health and mental health services in a complementary manner. In the first essay we discuss the issue of access to mental health services, and its impacts on other parts of the mental health system. We showed how poor access in the mental health services impacts the behaviour of patients in using the emergency departments as an alternative source for mental healthcare. We argued that a reason for poor access to mental healthcare services is the misalignment between the capacity and the demand in the mental health system. We suggested coordinated capacity allocation decisions for the mental health services and the emergency departments. The recommended strategies are useful guidelines to improve access to mental health services, reduce the high utilization of emergency departments, and manage the cost of the mental health system.

From a broader perspective, access is not limited to getting the mental health services, access extends to receiving mental healthcare when needed; in the right time and with the right quality (Levesque et al., 2013). Many mental health services suffer from quality issues. Mental health service providers often struggle to incorporate the characteristics of patients and populations in service design and delivery. In addition, mental health service providers are faced with limitations in financial resources and increasing cost. Within that, it becomes more challenging to provide the needed quality within resource and financial constraints.

The second essay in this study is motivated by the need for studies that focus on improving the quality of health and mental health services while managing the cost of those services. We investigated the different dimensions of quality in healthcare and mental healthcare. Within that we reviewed the two main factors of quality, and they are effectiveness and efficiency. We discuss

how the two elements of effectiveness and efficiency can be integrated in the mental health services while considering the needs and preferences of patients. We expanded our discussions to analyse the relation between effectiveness, efficiency and standardization, individualization in the mental health services. Individualization relates to meeting the different needs and preferences of patients while standardization relates to following the general medical and operational criteria in the delivery of health and mental health services. Based on our theoretical and numerical analysis, we derived directions for the design of mental health services incorporating individualization and standardization according to patients' needs. We express patients' preferences and needs via the patient utility function. Then analysed the relation between patients' behaviour towards risk, utility function and the design of healthcare/mental health services. Addressing the importance of cost management in the mental health system, we derived the optimal levels of individualization and standardization that minimize the total cost of mental health services and investigated how socio-economic and health factors shape that decision. The total cost of health/ mental health services is composed of the cost of providing individualization and standardization in healthcare or mental healthcare at operational and strategic levels. The second essay concludes important policy paths on the design of mental health services to deliver the needed quality for mental healthcare while addressing important patient and contextual elements.

Transferring to a more practical perspective, the third essay is directed to collaboration among mental health organizations in Nova Scotia. This replies to the vital need of mental health organizations in Nova Scotia to improve their capacities to meet the demand for mental healthcare. In addition to improving capacity, mental health organizations in Nova Scotia have expressed the importance of improving resilience to be able to deliver the needed services even in disruptive conditions. The study emphasizes the importance of collaboration as a tool to improve the

performance of mental health organizations in coordination with essays 1 and 2. The third essay includes an analysis of collaboration structures and their applications in healthcare and mental healthcare organizations. As well as a screening of mental heath organizations in Nova Scotia. Based on our literature review and analysis, we developed a framework for interorganizational collaboration among mental health organizations including a stepped process to form and assess the collaboration. Directed to the special context of Nova Scotia, we presented an organizational strategy and a technology plan for interorganizational collaboration to enhance capacity and resilience including criteria to choose best IT approaches. The study provides useful directions to initiate and expand collaboration among mental health organizations. We present functional models to build collaboration among health and mental health organizations to improve the delivery of services. The proposed models and frameworks can also be applied to other similar contexts in healthcare.

This thesis uses wide-ranging and inclusive methodologies to research the healthcare system in particular the mental health system in Canada. It replies to the essential need of improving the Canadian mental health services. We tackled correlated issues in the mental health services in Canada while incorporating the characteristics of patients as well as the dynamics of environmental and system factors. The presented structures and analysis form guide to validating the impact of gaps in the mental health services in Canada on the delivery of mental healthcare. The outcomes of this study provide a wide range of analysis and policy implications that connect several dimensions in healthcare and mental healthcare. The presented solutions can be used as pathways to the improvement of health and mental health services in Canada and other locations with similar characteristics.

2. Optimal Capacity Decisions for a Mental Health System with Patients Switching to Emergency Departments

2.1. Introduction

In this study, we refer to mental healthcare facilities outside the emergency department (ED) as mental health service providers (MHSPs) including primary care, mental health interventions, psychiatric therapy, and other related services (CIHI, 2019; North West LHIN, 2013). The mental health system (MHS) under consideration includes MHSPs and E.Ds. Sunderji et al. (2013) indicated that there are many access barriers to various mental health services in Canada including primary care, psychiatric care, and community care. Access issues in the mental health services impact the delivery of services and the patients. Research finds that poor access to MHSPs is a main cause of ED crowding, where many patients seek treatment when they do not get needed and timely treatment by MHSP (Begley et al., 2006; Leon et al., 2017; Moroz and Moroz, 2020). Increased ED utilization by mental health patients puts burdens on the MHS as well as on the patients (Mowbray and Omar, 2019). The high utilization of emergncy departments by mental health patietns have financial impacts on the mental health system. Studies show that the average cost of providing care to mental health patients in the ED is higher than within MHSPs (Sheridan et al., 2016; Stewart et al., 2006; Mapelli and Black, 2015). The high use of ED by mental health patients increases the total cost of the MHS (Mowbray and Omar, 2019; Van den Berg et al., 2016; Nicks and Manthey, 2012). Furthermore, mental health patients at the ED do not receive care designed for their needs (Flood and Thomas, 2002). The environment at the ED is not designed for mental health patients, and services at most EDs are not customized to care for patients with special mental health conditions. The crowding at the emergency departments disrupts the flow and creates backlogs and delays that prevent patients from receiving emergency care when needed. All these

points call for urgent actions to improve access and reduce the use of ED for preventable mental health issues. The main causes of poor access to MHSP are mismatches between capacity and demand for mental healthcare. As indicated the miscoordination among mental health services is a barrier to proper resource allocation plans. Research mentions that in services that suffer from high fragmentation, such as the Canadian mental health services (Leon et al. 2013), the right resource allocation decisions cannot be made. The need to establish collaboration among mental health services meets with the objective of the third essay that addresses the development of interorganizational collaboration among mental health organizations.

In this study we suggest comprehensive capacity allocation plans in the mental health system while minimizing the total cost of mental health services. Considering mental health service facilities of all types as one system supports capacity allocation decisions that consider the interactions between those services (Newton et al., 2012; Hibbard and Greene, 2013). Within the systems approach, it is important to understand the structure, dynamics, and complexity of the MHS, which comprises many programs that interact with each other and with other healthcare facilities. Of equal importance to consider are the complexities in MHSP in relation to patients' behaviour and other health and personal factors. In this research, first, we demonstrate the impact of gaps in one area of MHS on other areas: the impact of lack of access to MHSP on increased ED utilization, and the effect of unmet demand in MHSP on the total cost of MHS. Secondly, we include the factor of patients' behaviour in relation to access to MHSP represented by the switching factor. This factor represents the portion of patients that switch from MHSP to the ED in relation to personal, system, and health factors. In our model, we consider that some patients switch to the ED because they are not able to have access to MHSP in a timely manner. Thirdly, we determine optimal capacity decisions in MHSP and the ED to minimize the total cost of MHS and manage patients' switching. Due to the critical nature of mental healthcare, it is important to make the best possible capacity

decisions in advance. At the same time, capacity allocation policies should be comprehensive and cost effective. Capacity planning in the MHSP should consider the uncertain nature of the demand for mental health services. By developing a newsvendor (NV) model, we find the capacity optimal decisions that balance overutilization and underutilization of resources; we identify the factors of overage (holding, idle) and shortage costs in different mental healthcare services. The features of the NV method make it suitable for applications in the highly uncertain and vital mental health system (Porteus, 2008; De Kock et al., 2021). Unlike most research that focuses on operational-level decisions, this study integrates both operational and strategic-level decisions in the MHS. The rest of the essay is organized as follows. In section 2.2, we present a literature review. In section 2.3, we explain the models and solutions. Section 2.4 offers numerical analysis and in section 2.5, we present conclusions and policy implications.

2.2 Literature Review

This essay is related to studies of access problems to health and mental health services, high ED utilization, and the use of the NV model in health/mental health systems.

Access represents the degree to which people are able to get the needed services from healthcare or mental health services (The National Academy of Science, 2018). Access is not a one-time event. It is a continuous aspect that includes the first contact with the healthcare service provider as well as the continuation with the services if needed (Murray and Berwick, 2003). Like Murray and Berwick (2003), van der Voort et al. (2010), and van Bussel et al. (2018), we focus on access related to mismatches between capacity and demand in the MHSP. Studies state that using the ED as an alternative source of care for health/mental health conditions is a sign of lack of access to healthcare/mental healthcare facilities (Mowbray et al., 2019; Nicks and Manthey, 2012). In mental healthcare, when the needed mental health services are not available, the ED is the only option for

patients seeking help for mental health issues (Liddy et al., 2013). In Canada, a reported example of the relation between access problems in MHSP and ED crowding is in Northwestern Ontario. Data from Northwest Local Health Integration Network (LHIN) demonstrate that MHSP capacity is low in relation to demand for mental healthcare. These shortages in MHSP capacity cause access problems and increase the use of ED for mental healthcare treatment. Similarly, there is a high rate of ED visits related to mental health issues in Champlain, Ontario, associated with access and capacity issues in MHSP (CHAMPLAIN LHIN, 2017; Gill et al., 2017). Other Canadian cities and towns have similar conditions (Enard and Ganelin, 2013; Rosychuk et al., 2015; MHCC, 2017). Regarding youth who need mental healthcare, Canadian studies show that more than half of youth with mental health issues at the ED either had no access to a mental healthcare provider or had insufficient access to proper mental healthcare (Petersen et al., 1998; Ungar et al., 2016; Walrath et al., 2006).

A consequence of the high ED utilization by patients with mental health needs is the increase in the cost of the emergency department. Overall, the cost of care for mental health patients in the ED is much higher than the cost at other MHSP. The crowding of ED departments is another consequence of high ED utilization. The ED is basically designed to serve patients with urgent cases. It accepts all patients and is usually a crowded facility (Qiu, 2014). This crowding increase when more patients with preventable mental health cases visit the ED. This disturbs the flow at the ED (Grupp-Phelan et al., 2009), and harms the staff and other patients. Specifically, patients with mental health issues may have longer waits at the ED because of the need for special care and designated waiting locations (Gandhi et al., 2016). The conditions of many patients might have deteriorated due to non-availability of proper mental health services at the right time. Additionally, using the ED for mental healthcare can seriously affect patients' wellbeing (Nesper et al., 2010;

Rodriguez, 2015). The atmosphere in the ED is not meant for mental healthcare; it is overwhelming for mental health patients and there is no continuity of care after the ED visits (Liddy et al., 2013). Most ED mental health services are not customized to the needs of different patients.

Many scholars have explored the problem of access to healthcare facilities and MHSP and ED utilization (Newton et al., 2012; Van den Berg et al., 2016). For example, Mowbray et al. (2019) applied behavioural models in exploring factors that drive patients to use the ED for mental healthcare, Gill et al. (2017) investigated characteristics and conditions of patients that use the ED for mental health treatment, and Nesper et al. (2010) explored the relation between gaps in MHSP and increased ED use. In this work, we develop an analytical model that illustrates the influence of demand shortages in MHSP on ED utilization. We demonstrate how access problems in MHSP increase ED use by developing a newsvendor model that includes the effect of patients switching. In addition to access, there are other factors that drive mental health patients to go to the ED including lack of knowledge of available services, location, and stigma (Moroz et al., 2020; Mowbray et al., 2019). The cost of visiting MHSP is another factor that drives patients to use the ED for mental healthcare. This cost includes the cost of travel, and time taken off work. We like to note that sometimes, mental health patients pay some of the cost for MHSP either from pocket or insurance, such as in psychiatry or counseling services. When choosing health/mental services, patients usually hold a comparison of the costs and benefits of attending a certain healthcare/ mental health provider (Wun et al., 2010; Wolinsky and Steiber, 1982). In addition to cost factors, personal and psychological factors also influence patients' choice of healthcare services (Padgett, 1992; Wolinsky, 1998). The critical nature of mental healthcare and the direct relation to human lives imposes special consideration when planning mental health services. To meet the needs of patients, the necessary resources for mental health services should be pre-allocated before patients

acquire the services. As healthcare capacity cannot be stored for the future, needed capacity should be allocated to the MHSP before patients use the services (Levi et al., 2007; Wiler et al., 2011). This is challenging within the uncertain demand, the changing needs of patients, and the dynamic nature of mental healthcare services (Harper, 2002). Since the NV method is able to tackle the uncertainty in demand, it is suited for acute settings with uncertain demand (Chen et al., 2016; Zhu et al., 2020) like mental healthcare. The newsvendor method can overcome the limitations of many healthcare capacity allocation and scheduling methods in dealing with complex, dynamic, and highly uncertain systems (Ozen, 2014). The NV method is able to capture trade-offs between under- and overutilization of resources while satisfying a certain objective function (Qin et al., 2011; He et al., 2012). There are a lot of studies that used the newsvendor method in the context of healthcare. For example, He et al. (2012) used a NV approach to address staffing issues in the presence of varied workloads in a hospital. Weiss (1999) tackled the problem of minimizing the expected cost of waiting and idling in a hospital operating chamber. Ozen and Ozen (2014), and Balasubramanian (2013) applied a semi-NV approach to find the optimal physician panel size while incorporating medical case combination to minimize wait time in a medical clinic. Green et al. (2007) used a similar approach to measure the frequency of excess and suggested the best panel size for a medical facility. Zhu et al. (2020) used an empirical NV approach to allocate hospital beds to several categories of patients' demand in urgent conditions while maximizing the hospital profit. Unlike most studies that used the NV method in a specific health context, like hospitals and nursing homes, we applied the NV method in relation to the MHS as a whole. Most approaches in healthcare modelling target either the operational or the strategic level of healthcare process. The model used in this essay targets both strategic and operational levels simultaneously by allocating resources to different service types (ED and MHSP), while managing the total cost of the MHS.

The behaviour of movement between healthcare services relates to the concept of patients' choice. In some operations research literature, replacing one service with another is referred to as substitution or switching (Kok and Fisher, 2007). In some cases, a single product or service may have two or more different prices. This relates to healthcare services with different costs. Relating to this concept, Sen and Zhang. (1999) used a NV method to research the selling of a single item or service in different demand classes with different prices. Operationally, this resembles the replacement of products or services. They expressed customers' movement from low fare class to high fare class in relation to the demand differences of the two classes. This is related to the movement of patients between two health or mental health services as depicted in this study. We refer to the movement of patients from the MHSP to the ED as patients' switching. Customers' (resembling patients in this essay) movement between different products or services has been researched in relation to different factors like price differences (Zhang et al., 2010), and customer satisfaction (Yang and Peterson, 2004). Like Iversen and Lurås (2011), Sorbero et al. (2003) and Joffe et al. (1999) we refer to the movement of patients between different healthcare services as *switching*. The movement of patients among health services has been explored in different health settings like outpatient clinics and general health services (Iversen and Lurås, 2011; Sorbero et al., 2003; Ravichandran and Nagar, 2015). We introduce the factor of patient's switching and explore the influence of patients' switching on MHS decisions of optimal capacities. We also demonstrate the influence of patients' switching on the total cost of the MHS. The present study simultaneously addresses several issues in the MHS: access (capacity shortages), switching between different mental health services, capacity-allocating decisions in different contexts in MHS, and fragmentation in the mental health services. This research informs strategic and operational decisions to overcome high ED utilization by mental heath patients.

2.3. Models

In this section, we consider the resource (capacity) allocation problem for the mental health system (MHS) using a newsvendor model. The MHS consists of the MHSP and the emergency department (ED) for mental healthcare. The MHS determines the capacity for the MHSP (X_I) and the capacity for the ED (X_E) to minimize the total cost $C(X_I, X_E)$ of the system under uncertain demand:

$$\underset{X_I, X_E}{Min}\ C(X_I, X_E). \tag{1}$$

We first consider a benchmark case in which there is no switching of patients between MHSP and the ED. The list of notations is presented in Appendix A.

2.3.1 Benchmark case

In the benchmark case, the two capacity decisions are independent. We assume that two groups of patients are separate with known demand distributions: one group goes directly to the MHSP and the other goes directly to the ED. The probability distribution functions for the ED and MHSP demands are $f_E(.)$ and $f_I(.)$ with cumulative distribution functions $F_E(.)$ and $F_I(.)$, respectively. The demand distributions are independent because patients using the two services have different mental health needs. It should be noted that MHSP are designed for early and/or long-term treatment of patients with mental health conditions, while the ED is designed to treat patients in conditions of emergencies. The cost of the MHS includes the cost of the MHSP and the cost of ED

for mental healthcare. Figure 1 represents the case when there is no switching from MHSP to the ED.

When demand (D_I) for MHSP exceeds capacity (X_I), there is a shortage cost in the MHSP; when D_I is lower than X_I, a holding cost of the unutilized resource is incurred. The holding cost expresses the cost when the MHSP and or the ED are idle; when the services are available but there are no patients. The average cost of MHSP is then:
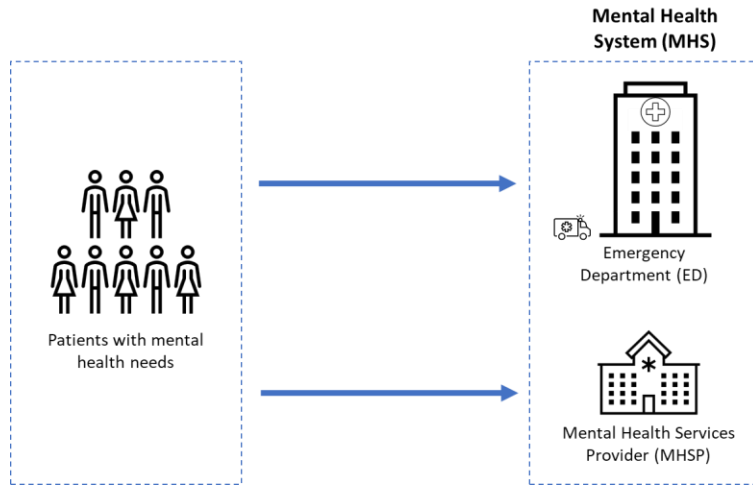

Figure 1: Mental health system (MHS) without patients switching.

$$C_I = c_I X_I + \begin{cases} S_I(D_I - X_I) & if \ D_I > X_I \\ h_I(X_I - D_I) & if \ D_I < X_I \end{cases} \qquad (2)$$

where c_I is the unit cost per patient in MHSP, S_I is the average shortage cost at the MHSP, and h_I is the average holding cost at the MHSP.

With Eq. (2), the total cost of MHSP can be written as:

$$C_I = c_I X_I + \int_0^{X_I} h_I(X_I - D_I)f_I(D_I)dD_I + \int_{X_I}^{\infty} S_I(D_I - X_I)f_I(D_I)dD_I . \qquad (3)$$

Similarly, the cost of services for mental health at the ED is:

$$C_E = c_E X_E + \int_0^{X_E} h_E (X_E - D_E) f_E(D_E) dD_E + \int_{X_E}^{\infty} S_E (D_E - X_E) f_E(D_E) dD_E . \tag{4}$$

The total cost of MHS will be the sum of the costs of MHSP and the ED for mental healthcare.

With Eqs. (3) and (4), the total cost of MHS is:

$$C = C_I + C_E \text{ or}$$

$$C(X_I, X_E) = C_I(X_I) + C_E(X_E). \tag{5}$$

With Eqs. (1) and (5), the MHS planner determines the allocation of capacities (X_I, X_E) to minimize

the total cost $C(X_I, X_E)$. The objective is to minimize the total cost for the mental health system

by finding the optimal capacities that achieve total cost minimization.

$$\underset{X_I, X_E}{Min}\, C(X_I, X_E) = \underset{X_I, X_E}{Min}\, (C_I(X_I) + C_E(X_E)) \tag{6}$$

In obtaining the optimal solutions, the following proposition holds:

Proposition 1: *There exists a unique optimal solution to X_j, which is given by:*

$$X_j^* = F_j^{-1}\left(\frac{S_j - c_j}{h_j + S_j}\right), \text{ where } j = \{I, E\}.$$

Note that X_I^* and X_E^* for MHSP and ED are independent as we consider the case that there is no

switching of patients between them. In the following subsection, we will consider the case when

patients switch from the MHSP to the ED.

2.3.2 Mental health system with switching

In this subsection, we consider the case of patients' switching between MHSP and ED. If capacity

in MHSP, (X_I), does not meet demand for MHSP (D_I), some patients cannot access the mental

health services they need. A portion of these patients may use the ED for treatment of mental heath

issues. That is, they will switch to the ED. As in Green et al. (2007), Sen and Zhang. (1999), and

VanBerkel and Blake (2007), we assume that the demand is realized sequentially in the assigned period. As in subsection 2.3.1, the probability distribution functions for ED and MHSP are $f_E(.)$ and $f_I(.)$ with cumulative distribution functions $F_E(.)$ and $F_I(.)$, respectively. Figure 2 illustrates the case with patient switching.
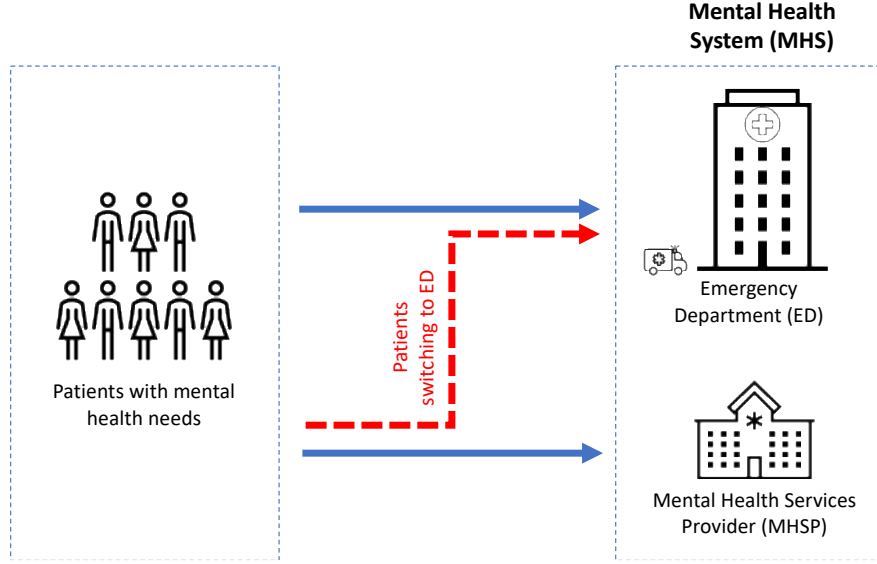

Figure 2: Mental health system (MHS) with patients switching.

In the figure, the switched patients are represented by the red dotted arrow. Studies indicate that MHSP are commonly under-capacitated and suffer from backlogs (Kutcher, 2001; CAPHC, 2010). Due to the high capacity shortages in the MHSP, the holding cost is zero (i.e., $h_I = 0$). The number of patients treated at the MHSP services is represented by:

$$X_I + \int_{X_I}^{\infty} ((D_I - X_I) - r\,(D_I - X_I))\, f(D_I)dD_I. \tag{7}$$

where r is the portion of patients beyond capacity (X_I) in the MHSP that switch to ED, $0 < r < 1$.

When r is very close to zero, the majority of patients use the MHSP for mental healthcare. While when r is very close to one, the majority of patients use the ED for mental healthcare.

Eq. (7) can be rewritten as:

$$X_I + \int_{X_I}^{\infty}((D_I(1-r) - X_I(1-r)))f(D_I)dD_I. \tag{8}$$

With Eq. (8), the cost for MHSP is:

$$C_I = c_I X_I + S_I(1-r)\int_{X_I}^{\infty}((D_I - X_I))f(D_I)dD_I. \tag{9}$$

The first and second terms in Eq. (9) represent the cost per patient at the MHSP and the shortage cost including the effect of switched patients.

The expected number of patients that switch to the ED is represented by:

$$R = r\int_{X_I}^{\infty}(D_I - X_I)f(D_I)dD_I. \tag{10}$$

When capacity at ED is insufficient, the cost of shortage at the ED is:

$$S_E \int_{X_E-R}^{\infty}((D_E + R) - X_E)f_E(D_E)dD_E. \tag{11}$$

Although the ED is generally overcrowded, there are conditions under which it is underutilized, such as emergency departments in remote areas with low population (Hsia et al., 2011) or at vacation times. When the capacity at the ED is more than the demand, the holding cost (cost of idle capacity) at the ED is:

$$h_E \int_0^{X_E-R}(X_E - (D_E + R))f_E(D_E)dD_E. \tag{12}$$

With Eqs. (10), (11) and (12), the total cost of the ED is:

$$C_E = c_E X_E + h_E \int_0^{X_E-R}(X_E - (D_E + R))f_E(D_E)dD_E + S_E \int_{X_E-R}^{\infty}((D_E + R) - X_E)f_E(D_E)dD_{E.}$$

(13)

With Eqs. (9) and (13), the total cost of MHS is:

$$C(X_I, X_E) = C_I(X_I) + C_E(X_E).$$ (14)

The MHS aims to minimize the total cost in Eq. (14) by allocating capacities (X_I, X_E).

$$\pi(X_I, X_E) = \underset{X_I, X_E}{Min}\ C(X_I, X_E)$$ (15)

With Eq. (15), we have the following result as summarized in Proposition 2:

Proposition 2: *There exists a unique optimal solution to (X_I, X_E), which is given by:*

$$X_I^* = F_I^{-1}[\frac{S_I(1-r)+c_E r-c_I}{S_I(1-r)+c_E r}]\ \ and\ X_E^* = F_E^{-1}\left(\frac{S_E-c_E}{S_E+h_E}\right) + R.$$

Proposition 2 shows that when $r = 0$, then $X_I^* = F_I^{-1}[\frac{S_I-c_I}{S_I}]$, which is the standard NV solution

without considering the holding cost in the MHSP, as MHSP has insufficient capacity. It can be

seen that X_E^* is an NV solution with the addition of R, where R is given in (10).

2.4. Numerical Studies

In this section, we apply numerical examples to provide additional insights and derive policy and

managerial implications of the proposed models.

2.4.1 Estimations on demands and associated costs

In numerical studies, we assume that demands for MHSP and ED follow uniform distributions

(Bieniek, 2018), where $f_I(D_I) = \frac{1}{a_1-b_1}$ and $f_E(D_E) = \frac{1}{a_2-b_2}$. The demand for mental health services

resembles the needed visits to the MHSP by patients. To provide explicit managerial insights and implications, using uniform distribution assumption allows us to examine the impacts of key parameters on capacity decisions of MHS. We assume that $a_1 > a_2$ and $b_1 \geq b_2$, as the demand for the MHSP is normally higher than for the ED.

Demand estimates

Demand capacity analysis of mental health services has been conducted by the Northwest Local Health Integration Network (LHIN) responsible for the planning, integration, and funding of the health system in Northwestern Ontario (North West LHIN, 2013). It is shown that demand for mental health service providers is higher than demand for the ED. Also, demand for MHSP in Northwestern Ontario is greater than the capacity of the MHSP, meaning that mental health services are under-capacitated. The estimation of demand for MHSP in Northwestern Ontario is summarized in Table 1.

Table 1: Estimation of demand for MHSP in Northwestern Ontario

Recognition of mental issues	Mild mental health issues	Moderate to severe mental health issues	Total annual demand
17,099	17,099	8,015	42,213

The total annual demand for mental health services is 42,213, approximated to 43,000. Scaled down by 100, the total demand for MHSP in Northwestern Ontario is 430. We will use this number as a base example of the demand estimation. In our analysis, we include variations of the base demand estimation according to the approximate sizes of the area of interest such as rural, urban, and

suburban populations and other contextual and demographic factors. We will analyze how policy decisions for optimal capacities vary according to differences in demand in the MHS.

The population of Northwestern Ontario was approximately 235,000 in 2013. Relating to ED, the crude rate of ED utilization for mental health conditions per 100,000 population was approximately 897.2 annualized (North West LHIN, 2013). Utilization of the ED by patients with mental health conditions according to the population is 2,180. Scaled down by 100 and rounded, it comes to 22. Those estimates help us understand the relation between demands for MHSP and for ED in Northwestern Ontario. Although other areas have different demand figures according to the population and context, this gives a general picture and pattern of demand and capacity for MHSP and ED.

Cost parameter estimates

Shortage cost: The shortage cost in a health intervention represents the consequences of not receiving the health or the mental health intervention when needed (Palmer and Raftery, 1999), or the offset of the opportunity of receiving the needed intervention at the needed time. Direct and indirect factors influence the shortage cost, such as the need for social and health support, absence from work, and worsening of the health/mental health condition. It is reported that the shortage cost for healthcare/mental health care increases with wait times (CAPHC, 2010; Hsia et al., 2011; Palmer and Raftery, 1999; Barua et al., 2016). When a patient does not have access to healthcare/mental health services for a long time, the severity of the health/mental health condition and the shortage cost increase. This is very clear in mental health conditions due to the complexity of many mental health cases and the interaction between mental health, physical health, and personal related factors. It is indicated that the average wait time for mental health counselling in

different areas in Canada can be up to 65 days.[3] The average shortage cost for non-admitted patients at the ED in Ontario is around $150. The estimated cost due to work losses resulting from mental illness in Canada was around $762 million in 2013 (Institute of Health Economics, 2008).

Cost per patient in the MHS: Table 2 portrays the costs of using the ED for mental health treatment versus MHSP in Canada. Costs for an ED visit for mental health in various regions are as follows: $225 in central Toronto; $120 in Northeastern Ontario; $140 in Central West (North West LHIN, 2013), whereas the average cost of a visit to a family physician is $50.[4] The World Health Organization estimates that the cost for a 20-minute visit to a health centre in Canada is $30 to $40.[5] Note that some family physicians provide services for moderate mental health issues. A doctor's visit in Alberta costs $60 for an uninsured individual.[6] The cost for private counselling or therapy for depression can range from $50 to $240.[7] We will build the cost estimates in relation to the stated cost figures. In our numerical studies, we consider the cost of mild or medium mental health intervention to be $40–$70.

Patients' switching rate

We assume that the switching rate of patients, r is a constant that depends on personal factors related to patients' choice. In our model we will not discuss those factors. A common range for r in many mental health services is between 0.3 and 0.4 (Niedzwiecki et al., 2018; Hsia et al., 2017). Table 2 presents the basic values for the base parameters considered in our numerical studies. We might use different values according to the contextual and cost factors considered in the analysis.

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[3] https://yourhealthsystem.cihi.ca/hsp
[4] https://globalnews.ca/news/381781/by-the-numbers-doctors-fees-across-canada.
[5] https://www.who.int/choice/country/can/cost/en/
[6] https://mcithedoctorsoffice.ca/policies/uninsured-services-pricing
[7] https://depression.informedchoices.ca

Table 2: Basic parameter values

Parameter	Basic value
Per patient cost at MHSP (c_I)	$ 50
Per patient cost in the ED (c_E)	$150
Switching rate (r)	0.3-0.4

2.4.2 Numerical Analysis

In conducting our numerical analysis, the following operational conditions should be satisfied:

- $S_E > c_E$ because the ED usually sees a high shortage cost due to crowding and the severity of most presentations at the ED (Hwang et al., 2011; Asplin et al., 2003).
- $c_E > c_I$ as the cost at the ED is higher than the cost of MHSP as indicated in the introduction.
- $c_E > h_E$ given that the holding cost at the ED is small in comparison with the unit cost, and it only occurs in rare situations.
- $X_E - R > b_2$ and $X_E - R < a_2$ given that the demand under switching to the ED should not exceed the original ED demand.

a- The impact of switching rate on capacity decisions in the mental health system

Figure 3 illustrates the impact of the portion of patients that switch from MHSP to ED represented by the switching rate (r) on the optimal capacities of the MHSP and ED. We take a case where demand for the MHSP is twice that of the ED. We set $a_1 = 700, b_1 = 0, a_2 = 350, b_2 = 0, c_E = 150, c_I = 50, h_E = 60, S_E = 160,$ and $S_I = 80$.
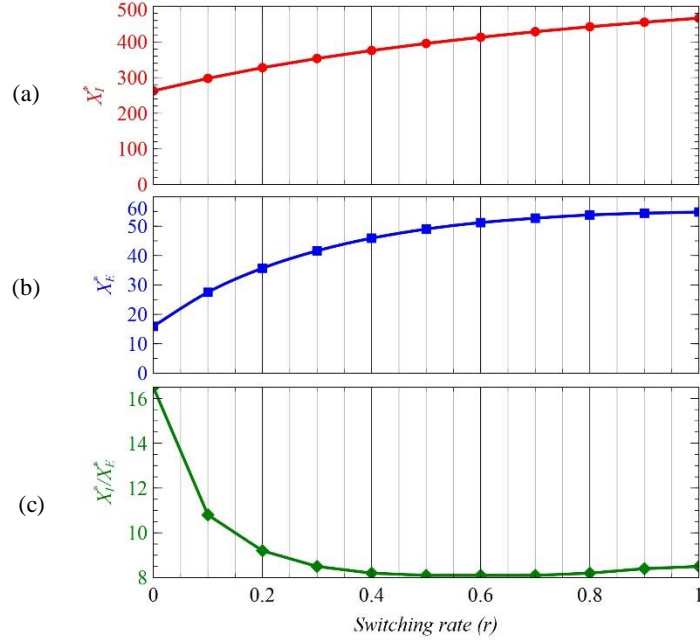
Figure 3: The impacts of r on $X_I^*, X_E^*,$ and X_I^*/X_E^*

From Figure 3, we can see that for all values of r, the suggested optimal capacity of MHSP is higher than that for the ED because demand for the MHSP is higher than demand for the ED. As indicated, MHSP capacity is less than demand for the MHSP. In general, the optimal capacities at MHSP (X_I^*), and the ED (X_E^*) increase with r. When $r = 0$, no patients switch to the ED and all go to one source for treatment, which is MHSP. This expresses an ideal situation. When $r = 1$, all patients would use the ED as a source of mental health treatment. This resembles a case in which the ED provides all types of healthcare services including mental health and can consist of an outpatient clinic.

We can see that the increase in X_E^* slows down with r, and the rate X_I^* / X_E^* decreases with r. To further examine the behaviour of X_I^*/X_E^*, we set $r_1 = 0.5,$ and $r_2 = 0.7$. From Figure 3(c) we can see that when $0 < r < r_1$, X_I^*/X_E^* decreases sharply. When $r_1 \leq r \leq r_2$, X_I^*/X_E^* is stable, and when $r_2 < r < 1$, X_I^*/X_E^* increases slightly. The explanation is that when a portion of patients, r, switch from MHSP to ED, the primary decision would be to increase the capacity of the MHSP to

overcome the capacity demand mismatches and reduce the number of switched patients. At the same time, the capacity of the ED needs to be increased to meet increased demand due to patients' switching. At higher values of r ($r_2 < r < 1$), X_I^* needs to be higher. When the MHSP is supplied with the needed capacity, fewer patients switch to the ED. This slows down the rate of increase in the ED capacity X_E^* .

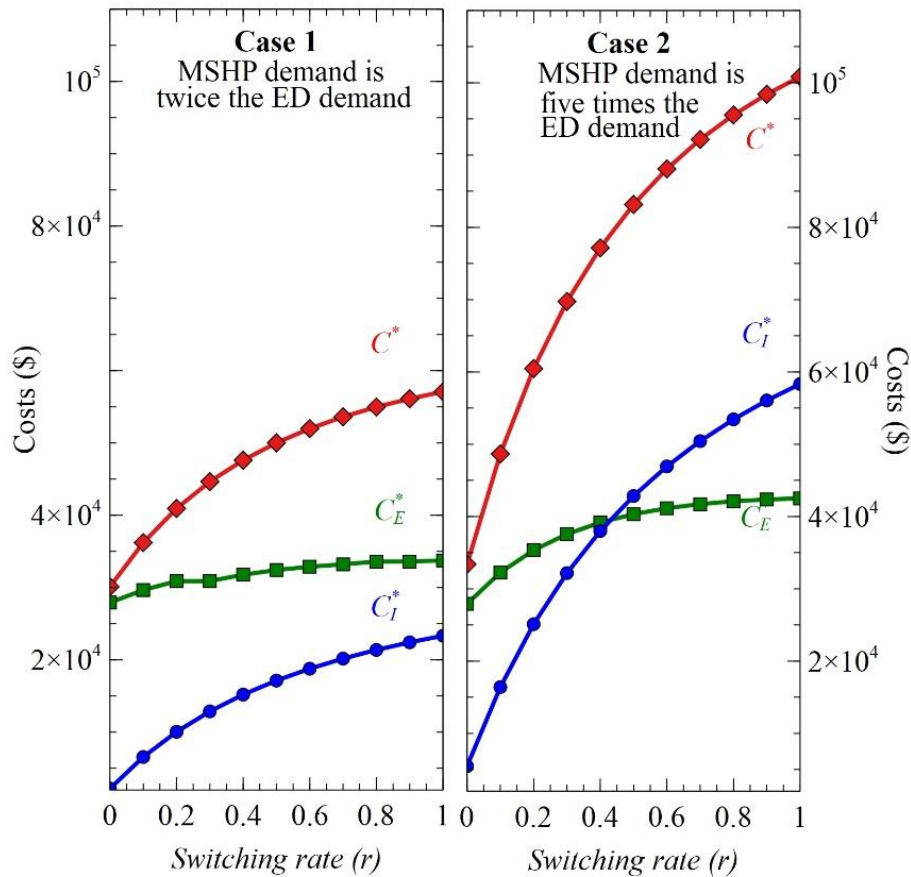**b. The relation between switching rate and costs in the mental health system**

Figure 4: The impacts of r on C_I^* , C_E^* and C^* for two demand ratios

In this subsection, we study the relation between $r,$ the cost of MHSP, the cost of ED, and the total cost of the MHS at optimal conditions. We set the demand at the ED as $a_2 = 350, b_2 = 0,$ and vary the demand at the MHSP to analyse the impact of demand variations at the MHSP on the costs

of the MHS. We study two cases: when the demand at the MHSP is twice the demand at the ED, and when the demand at MHSP is five times the demand at the ED. We set the parameters as: $a_1 = 750$ and $1750, b_1 = 0, a_2 = 350, b_2 = 0, c_E = 150, c_I = 50, h_E = 60, S_E = 160$, and $S_I = 80$. Figure 4 illustrates the impact of r on C_I^*, C_E^*, and C^* when the demand at the MHSP is two and five times the demand at the ED. From Figure 4, as expected, we can see that the total cost of the MHSP (C_I^*), the total cost of the ED (C_E^*), and the total cost of the MHS (C^*) increase with r. We discuss the two following cases.

Case 1: the demand at the MHSP is twice the demand at the ED as depicted in Figure 4. For all values of r, the total cost of the ED (green curve) is higher than the total cost of the MHSP (blue curve). When r increases to higher levels, the rates of increase in C_E^* and C^* slow down. The explanation is similar to the one provided in the previous subsection. At higher values of r, the initial strategic decision would be to provide high capacities at the MHSP. This would reduce the number of patients switching to the ED. When the number of switched patients is less, the needed increase in the ED optimal capacity is less, which slows the increase in the ED total cost. As the ED's total cost is higher than the MHSP's total cost, the rate of increase in the cost of MHS slows down at higher values of r following the ED cost.

Case 2: the demand at the MHSP is five times the demand at the ED. In this case, for all $r > 0$, C_I^*, and C^* are higher than in Case 1. This is due to the high demand for the MHSP, the high-capacity needs at the MHSP, and the ED. Also, the total costs of the MHS and the ED significantly increase with r. Increasing r increases the expected average of switched patients, R, and directs more capacity needs at the MHSP and the ED. The high demand for MHSP in this case requires high capacities in the mental health services to meet that demand. This significantly increases the cost of the MHSP, and the total cost of the MHS as providing more capacities incurs higher cost.

In this case, we notice that when r is small, $C_E^* > C_I^*$ and when r is large, $C_I^* > C_E^*$. The increased needs of capacity for the MHSP at higher levels of r escalates the cost of the MHSP and the total cost of the MHS. On the other hand, providing MHSP capacity reduces the variation between demand and capacity at the MHSP and reduces the number of patients that switch to the ED which slows the increase of the ED cost. To further illustrate this, we refer to Eq. (10). The expected number of patients that switch to the ED, depends on the switching rate as well as on the average under capacity at the MHSP. Increasing the capacity of the MHSP decreases the average under capacity at the MHSP and thus reduces the average number of patients that switch to the ED department for mental healthcare.

c. Comparing rural, urban, and suburban areas' capacity decisions

The demands for ED and MHSP differ according to the location: rural, suburban, and urban. Other factors that influence the demands for the ED and the MHSP include cultural factors, personal choices, distance from the ED and the MHSP, stigma, cost of travel, trust in the MHSP, availability of information and others (Caxaj, 2016; Dyck and Tiessen, 2015). In rural areas both the demands for the MHSP and the ED are comparatively low. While in suburban areas, demand for MHSP is in the medium range and demand for ED is higher than in rural areas (Fleury et al., 2019). In urban areas, the demand for both ED and MHSP is higher than rural and suburban areas. As noted, in most locations, MHSP in Canada are under-capacitated with demand higher than the available capacities (Weinhold and Gurtner, 2014; Friesen, 2019). Since the needs for mental health services vary across locations, it is important to incorporate location factors in the planning of mental health services. In this research we will analyse differences between rural, urban, and suburban areas relating to capacity allocations in the MHS as depicted in Figure 5. We analyse the impact of r on the total cost of the MHS in those three areas. To limit the effect of cost variations,

we assume that the holding cost for ED is $h_E = 60$, and the shortage cost for MHSP and the ED are $S_E = 160$, and $S_I=80$, respectively. We set the parameters as in Table 3.

Table 3: Cost and demand variations in urban, suburban, and rural areas.

	Urban	Suburban	*Rural*
Demand for ED	$a_2 = 8000, b_2 = 0$	$a_2 = 2500, b_2 = 0$	$a_2 = 400, b_2 = 0$
Demand for	$a_1 = 20000, b_1 = 0$	$a_1 = 6500, b_1 = 0$	$a_1 = 1400, b_1 = 0$
c_E	$c_E = 150$	$c_E = 150$	$c_E = 150$
c_I	$c_I = 50$	$c_I = 50, 60$	$c_I = 50$

Figure 5 reveals that the needed optimal capacities for MHSP and the ED increase with r. In all cases, $X_I^* > X_E^*$. The needed optimal capacity in the MHSP is less for rural areas. The needed capacity for MHSP is greater in urban areas than in suburban and rural areas. These differences are related to the variation in demand for MHS in the three areas. Especially in urban and suburban areas, capacity needs in the MHSP are high. This means that more resources need to be directed to building capacity in those areas. The low values in ED capacities compared to MHSP capacities are because we direct the demand of ED for mental health services, and not all the ED department. Also, the used estimates are scaled down. Despite that, the use of ED services by mental health patients has obvious effects on the costs and the ED operations, as mentioned previously.

For the specific illustrative example in this section, it is noticed that the ratio X_I^*/X_E^* is very similar between suburban and urban areas for all values of the switching rate. This means that once a reasonable ratio between MSHP and ED capacities is found, it can be used by decision makers regardless of the application area being urban or suburban. Furthermore, it can be observed that

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this ratio X_I^*/X_E^* is again similar between rural, suburban, and urban areas when the switching ratio is greater than 0.3. Thus, the recommendation would be to use the same capacity design ratio unless the switching rate is low in the rural case. In the next subsection, we investigate the impact of unit ED cost on capacity decisions in the MHSP.
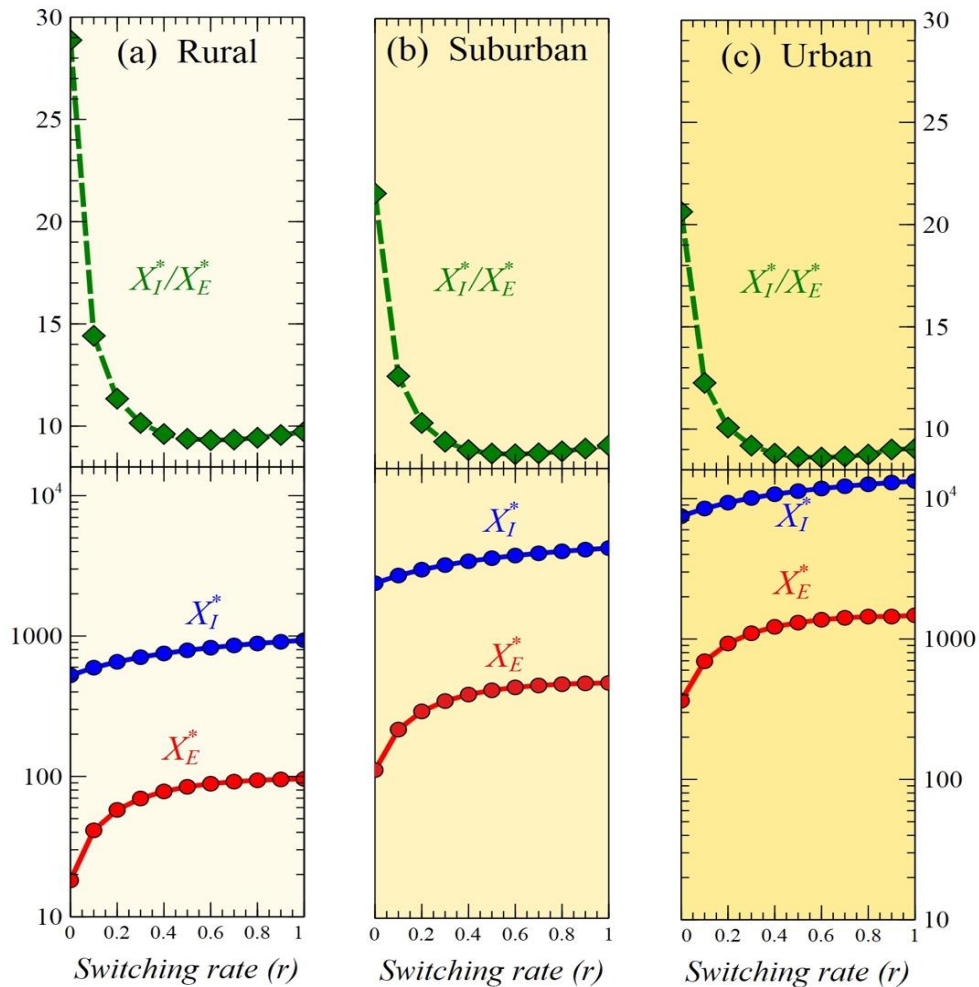

Figure 5: Impacts of r on ED and MHSP capacities for rural, suburban, and urban

d. The impact of ED cost on the capacity of mental health service providers.

Figure 6 shows the impact of the unit per patient cost at ED, c_E on the optimal capacity of MHSP, X_I*. We set $a_1 = 1750$, $b_1 = 0$, $a_2 = 350$, $b_2 = 0$, $r = 0.4$, $c_E = 150$, $c_I = 50$, $h_E = 60$, and $r = 0.35$.
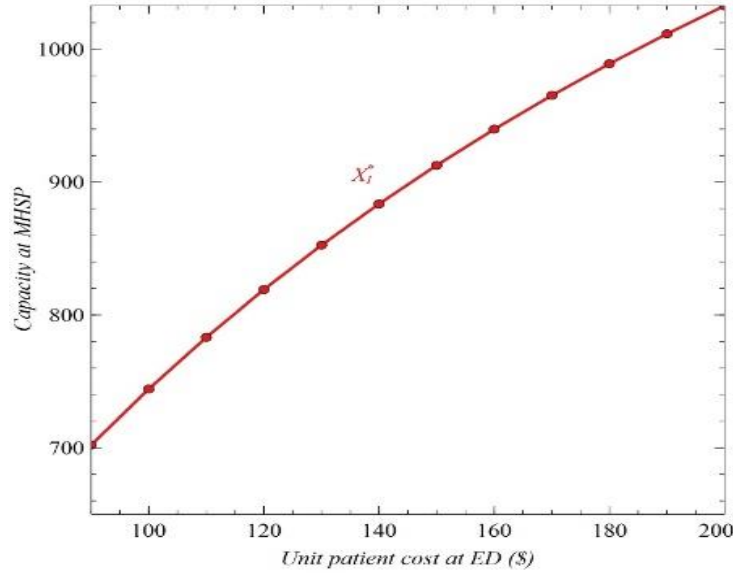

Figure 6: The impact of c_E on X_I*

The average per-patient cost at the ED for mental healthcare differs according to factors such as location of the ED and the context. As mentioned above, in most conditions, the cost of treating patients at the ED is higher than the cost of treating patients at the MHSP. From Figure 6, we can see that X_I* increases with c_E. When the cost at the ED is high, the total cost of the MHS increases. The MHS tries to reduce the high cost of the MHS and the number of switched patients. The best strategy is to increase the capacity in the MHSP to meet the needs of patients for mental healthcare. That is why we see the increase in X_I* with c_E. In the next section we will analyse the effect of cost variations between the ED and the MHSP on the capacity decisions.

e. The impact of differences between ED and MHSP unit costs on capacity decisions

In this example, we capture how the differences between the unit costs in the ED and the MHSP, $(c_E - c_I)$, impact optimal capacity decisions in the MHS. We set parameters as: $a_1 = 6500, b_1 = 0, a_2 = 2500, b_2 = 0, h_E = 60, S_E = 160$, and $S_I = 80$. Figure 7 illustrates three cases: $c_E - c_I = 120 - 50 = 70$, $c_E - c_I = 90 - 50 = 40$, and $c_E - c_I = 90 - 60 = 30$.
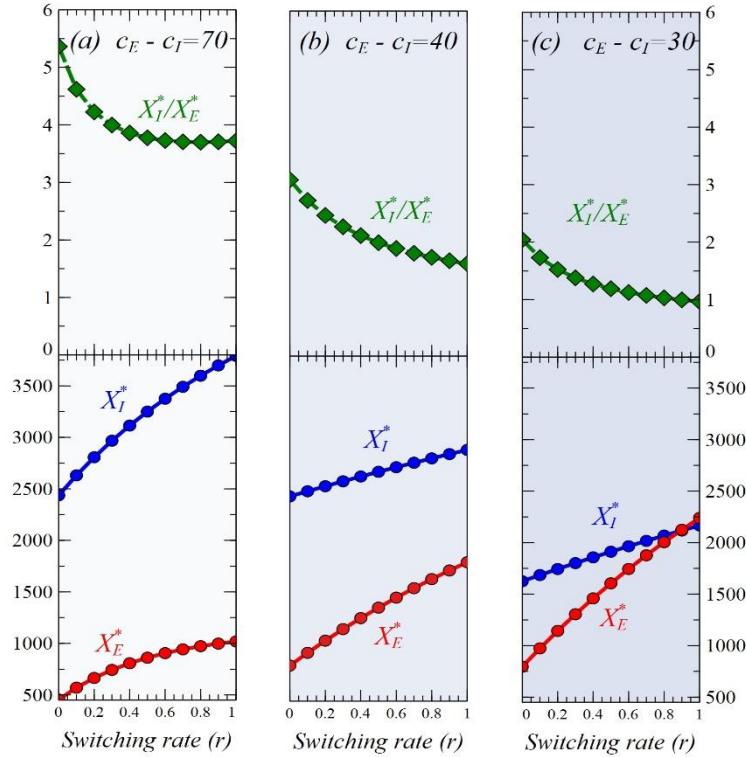

Figure 7: The impact of r on optimal capacities relating to cost differences.

From Figure 7, we can see that the ED capacity and the MHSP capacity at optimal point increase with r. The difference between the MHSP optimal capacity and the ED capacity (X_I*-X_E*) and the rate of X_I^*/X_E^* are less when $c_E - c_I$ is less. Also, (X_I*-X_E*) and X_I^*/X_E^* are less with increasing r for all cases. Figures 7(a) and 7(b) resemble the cases when $c_E - c_I = 70$ and $c_E - c_I = 40$. We can see that the MHSP capacity is more than the ED capacity for all r. In Figure 7(c) the difference

between $c_E - c_I$ is 30, which is less than in the first two cases. The cost of the ED, $c_E = 90$, is closer to the cost of the MHSP, $c_I = 60$. In this case, the MHSP optimal capacity is more than the ED optimal capacity when r is small or medium. With increasing r, the difference between the two capacities is less. This indicates that at some conditions, equal capacities can be assigned to the ED and the MHSP. When the unit ED cost is not so high compared to the unit MHSP cost, some different cost management strategies can be applied. For example, when c_E is closer to c_I, ED centres for mental healthcare can be initiated considering the availability of the right skills and capacities. These approaches are discussed in detail in the policy implications subsection.

f. The impact of shortage costs on optimal capacity decisions

In this subsection, we will numerically examine the impact of the shortage costs of MHSP and the ED, (S_I and S_E), on the optimal capacities of MHSP and the ED. We set $a_1 = 1750, b_1 = 0, a_2 = 350, b_2 = 0, r = 0.4, c_E = 150, c_I = 50$, and $h_E = 60$. Figure 8 illustrates the relations between S_I and X_I^*, S_I and X_I^*/S_I, S_E and X_E^*, and X_E^*/S_E.
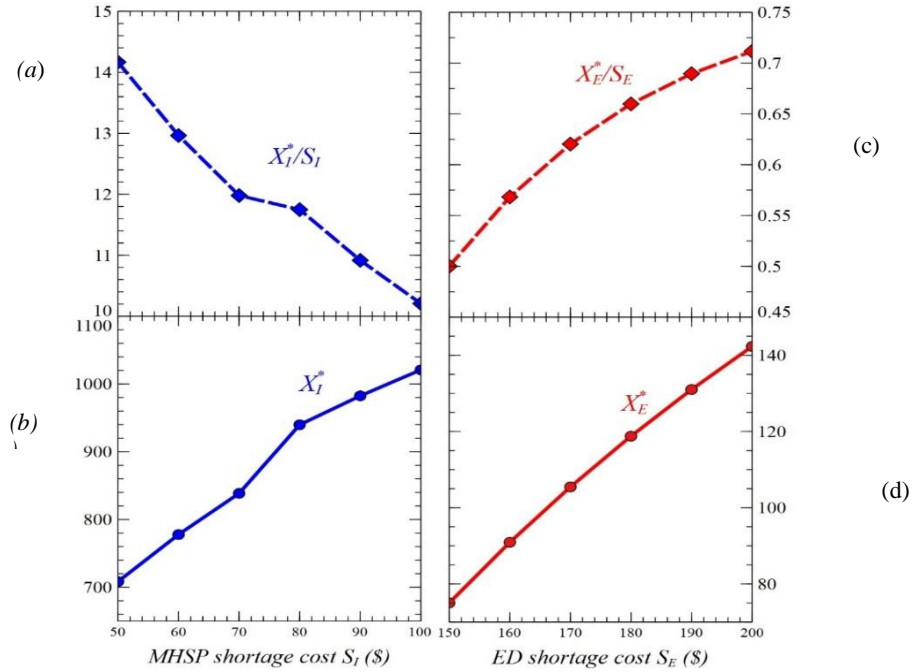
Figure 8: The relation between (a) S_I and X_I^*/S_I , (b) S_I and X_I^*, (c) S_E and X_E^*, and (d) S_E and X_E^*/S_E

When the shortage costs at the MHSP and the ED increase, the strategic decision would be to increase the MHSP and ED capacities respectively. As mentioned, the shortage cost increases with the severity of health/mental health conditions, special patient conditions, and/or socioeconomic and environmental conditions. The shortage costs in the MHS also increase with time since the severity of the mental health issues increases with time of not receiving the needed care for mental health (WTA 2017). The average shortage cost at the ED is nearly twice the average shortage cost at the MHSP. This is due to the critical, time-sensitive nature of most presentations at the emergency department services.[8] From Figure 8, we can see that X_E^*/S_E increases with S_E while X_I^*/S_I decreases with S_I. The needed capacities at the ED for mental healthcare are various, and

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[8] https://www.duvasawko.com/capacity-management/

costlier, due to the unique ED environment and the urgency of cases. The number of facilities (e.g., specialized care, isolated areas, and supervision) needed for mental health patients at the ED increase with the severity of the ED presentations (Greene, 2021; American College of Emergency Physicians, 2014). On the other hand, the urgency is the MHSP is less. Also, the types of capacities for mental healthcare can be shared over time in MHSP. Mental health services are specialized for mental healthcare and include safe spaces, so there is less need for special crisis areas. The facilities for MHSP can be used for a range of medium to mild severity cases. Establishing the needed capacity for MHSP early enable the sharing of these capacities among different providers and using them in future times (Bartram and Chodos, 2013). Importantly, coordination among mental health MHSPs facilitates capacity sharing in the MHS and improves access (Kates at al., 2010). This connects to the scope of essay 3, where we discuss how to establish collaboration among mental health organizations. In the next session we review conclusions and policy implications.

2.5. Discussion

2.5.1 Conclusions

In this essay, we analysed the relation between access to MHSP and the total cost of the MHS. We investigate access challenges in relation to misalignments between demand for and capacity in the MHSP. We also demonstrated the impact of location and price differences on capacity decisions in the MHS. Through the models we quantitively demonstrated the dynamics between important links in the MHS. By using the NV method, we were able to integrate strategic and operational aspects of the MHS by combining the optimal decisions to minimize the total cost of MHS and the capacity allocation decisions for the ED and MHSP. We provided insights into mental health service design and resource allocation considering factors like patients' behaviour, location of the

services, and the conditions of patients. Researching causes of crowding and how to manage that is a very crucial area, especially with the crowding of ED departments in Canada. The lived challenges of COVID-19 placed an immense burden on the health system in general and specifically on the mental health intervention services and emergency departments. Demand for all services has increased significantly. Those challenges are greater when the health and mental health system already suffer from challenges. This study replies to the importance of addressing capacity issues to build a robust mental health system that can reply to the needs of patients and adapt to emergencies and surges in demand. In the next sub-section, we present important policy implications.

2.5.2   Policy Implications

a.   The impact of insufficient access to MHSP on the MHS

In our analysis, we showed that the capacity-demand misalignments in the MHSP has a significant effect on the cost of MHSP, especially when the demand for MHSP is high and the unit cost at the ED is high. The total cost of the MHS increases when the gap between demand and the capacity in the MHSP grows larger and patients' switching increases as demonstrated in Figure 5. In Figure 9 we can see how the demand capacity mismatches in the MHSP, and the portion of patients that switch to the ED increase the total cost of MHS.
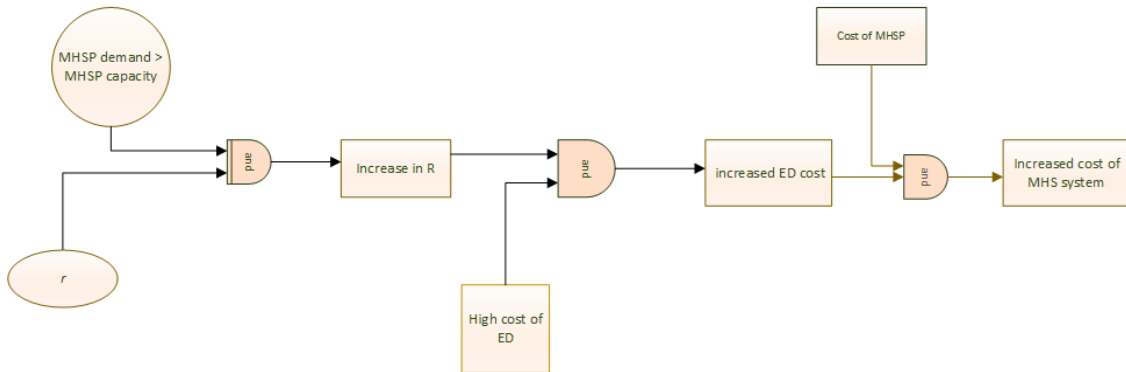
Figure 9: The impacts of r and the capacity shortages on R and the total cost of the MHS.

The figure shows that the factors of capacity disparities and r, the portion of patients that switch to the ED contribute to increase R, the number of expected patients that switch to the ED. When R increases, and the cost of the ED is high, the total cost of the MHS increases. This points to the significance of early and correct strategic decisions to overcome access disparities in the MHS.

b. **Importance of comprehensive approaches in the MHS**

Miscoordination among mental health services is a main reason for poor capacity and resource allocation decisions. For example, when high utilization of the ED by mental health patients is observed in isolation, recommended solutions might focus on increasing ED capacity while neglecting other parts of the mental health services. Such decisions will not tackle the cause of the problem and will result in wrong resource allocation choices. To address the problem in a holistic manner, solutions to high ED utilization should consider different links in the MHS such as access to the MHSP, the cost of MHS, and crowding at the

ED. By our analysis, we validated the impacts of comprehensive and holistic solutions to high ED utilization in improving the MHSP capacity, providing the needed ED capacity and managing the cost of the MHS.

c. Capacity decisions in the MHS

From the analysis, we conclude that the primary decision in the MHS is to provide the needed capacity in the MHSP to address the problem of access. This should be accompanied by proper capacity design in the ED that considers the uniqueness of mental health conditions. We noted that the mismatches between capacity and demand in the MHSP highly increases the number of patients that switch to the ED and the cost of the MHS. We should know that even if capacity in the MHSP is sufficient to meet the demand, there would still be some patients that switch to the ED due to behavioural, distance, health, and personal reasons. In setting capacity and resource allocation plans in the MHS, both the amount and the types of capacities for those facilities should be considered. Due to the differences between the ED and the MHSP operations, some forms of the needed capacities are different. Providing capacity in the MHSP can take forms like staff training, specialized programs, hiring specialized personnel, establishing specialized MHSP service locations, using electronic records, and applying assistive methods of treatment (such as e-treatment). Important capacity needs at the ED may include extending and managing shifts, increasing emergency beds, and others (Innes et al., 2013). An important requirement in the ED is providing a safe environment for patients with separate areas and a therapeutic environment[9] when needed and providing supervision for patients. We recommend that MHSP of all kinds to be designed for long-term specialized

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[9] https://www.hfmmagazine.com/articles/3486-behavioral-health-design-strategies

treatment, mental health interventions, and care for mental health conditions of different severities.

d. The importance of early solutions in MHS

From Figures (3) and (5), we see that the cost of MHS can be greatly reduced by providing capacity at the MHSP to meet the demand for mental healthcare. It is important to make the correct capacity decisions at the earliest sign of access issues in the MHSP and not let those issues accumulate. Even if the rate of switching, r, is small, mental health planners should address capacity shortages in the MHS to save the financial, societal, and health costs of delayed actions. Allocating the right capacities to the mental health services not only improves the short-term operation but provides better mental health delivery in longer terms. Noting that capacity allocation decisions should be updated due to the changing demand and requirements of patients. The model used in this study suggests optimal capacity decisions for one time period. In consecutive time periods capacity decisions should be adapted. The assigned time limits to update the capacity decisions depend on the strategic goals and the structure of the MHS. An interesting application of the NV outside our scope is the multiperiod NV problem that can assign capacity allocation for more that one time period. In Figure 10, we can see how providing the needed capacity in the MHSP reduces the total cost of the MHS and the crowding at the ED.
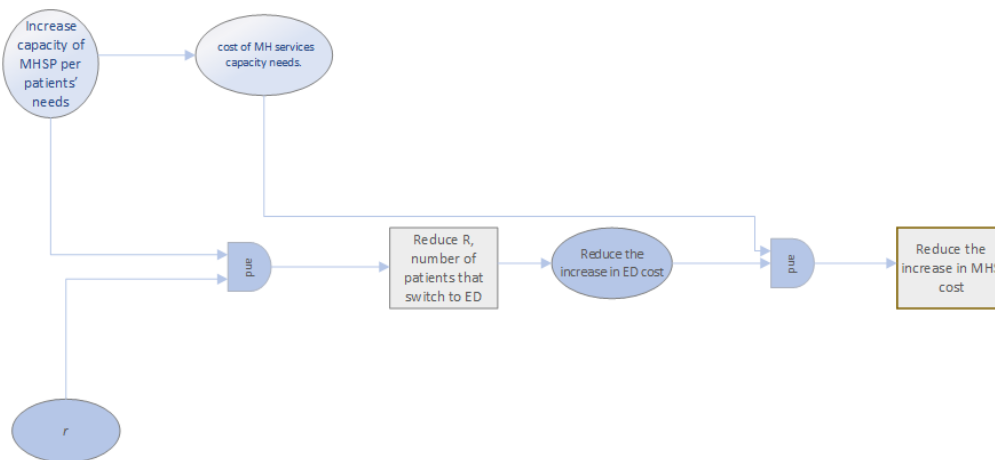
Figure 10: The impacts of adequate capacity decisions on R, and the total cost of MHS.

e. The relation between cost variations and the optimal decision

The limitation of resources in the mental health system highlights the importance of planning capacity allocation decisions while managing the cost of MHS. The objective of our model was to assign the optimal capacities to minimize the total cost of the MHS. One of the factors that impacts the allocation of optimal capacities in the mental health services is the variations between the unit costs of the MHSP and the ED. In the following we present three directions for resource allocations depending on the differences between c_E and c_I.

- When $c_E - c_I$ is high, which is the most common situation in MHS, the initial strategic decision is to provide the needed capacities to the MHSP to manage the number of patients that switch to the ED. Also, supply the ED with the capacity needed for the remaining patients that use the ED for mental healthcare. As mentioned, even if the MHSP had the

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sufficient capacity needs, some patients still switch to the ED for personal and other reasons. In this case, the capacity at the MHSP is much higher that the capacity at the ED; to manage the total cost of the MHS a tactical decision is to reduce the use of ED by mental health patients as much as possible.

- When $c_E - c_I$ is less, it could be useful to let some patients use the ED for mild and moderate cases. A portion of capacities can be shared between the ED and MHSP, such as capacity sharing between primary care and the ED.

- When $c_E - c_I$ is very small, a strategic decision can be made to use the ED for mental healthcare by opening ED hubs or ED centers for mental health.

f. Considering patient related conditions in capacity allocation decisions

The shortage costs in the MHSP and ED increase with the severity of the mental health conditions. The increase in shortage cost points to the need to expand mental health capacities or provide other types of capacities to address the unique conditions of patients and/or populations. In addition to providing the needed mental healthcare, attention should be paid to the socio-economic conditions of patients. Research shows a high correlation between poor socioeconomic conditions and the prevalence of mental health conditions (Smith et al., 2008). Special attention is needed to enhance the socio-economic conditions of disadvantaged populations to reduce the prevalence of mental health issues for these populations. In essay 2 we will focus on how to meet the needs of different patients and populations when designing mental health services. Higher shortage cost also points to comorbidities of mental health and general health conditions which calls for special considerations in allocating capacities. Early provision of the right capacities and resources to meet the demand for mental healthcare helps

to avoid the increased shortage cost as the complication of non-addressed mental health and related issues increases with time.

g. Impact of location factors on capacity decisions in MHS

The utilization of healthcare resources varies according to individual factors, area-level factors, and health-related behaviour (Wilk et al., 2020). An important factor in the design of healthcare and mental health services is the location of mental health services. It is important to incorporate contextual and location elements when planning capacities in the mental health system. As indicates the demand for MHSP in all locations is more than the capacity. The analysis in this study shows that the ratio of the optimal capacity in the MHSP and the optimal capacity in the ED is close in suburban and urban areas. A useful strategy would be to determine this ratio and use it to direct capacity planning. It is useful to form estimation of this ratio when allocating capacities for other areas with different demand variations.

A potential solution to ED crowding in urban and large cities with high ED cost is to open ambulatory clinics for cases of medium urgency, in addition to the main ED. These units can provide care for less urgent mental health cases at lower cost (Rechel et al., 2016). It is also suggested that using telemedicine assessment services can support assessment of mental health patients when psychiatrists are not available at the ED (American College of Emergency Physicians, 2013).

The location analysis for rural areas where 6% of Canadians live (Fleet, 2020) has important policy implications. In rural areas, mainly MHSP are often distant and hiring staff is expensive. One of the main obstacles to accessing healthcare facilities in rural areas is the cost and difficulty of transportation. Improving coordination between health, mental health, and other

community services to arrange suitable transport for patients is a useful approach. Another approach is using the internet and/or phone to offer care for medium to moderate mental health issues. In rural and remote areas, EDs can include mental healthcare units via attached outpatient clinics or ED hubs. In addition, establishing interdisciplinary teams helps to build capacities for mental health services, especially when there are challenges, such as those found in rural areas or areas with limited resources. Essay 3 reviews the benefits of collaboration among mental health services.

2.5.3 Limitations and future directions

In this study, we used parameters and discussions from mental health services, but the same concepts can be applied to other healthcare contexts after considering differences. Although the objective in this work is to minimize the total cost of the mental healthcare system, we are motivated by the wellbeing of patients. When the costs in the MHS are better managed, they can be directed to areas of need to improve the services. In our discussions, we addressed one direction of movement—from MHSP to the ED. It would be interesting to explore the movement from ED to MHSP after patients receive mental health care at the ED. This can be applied using a different mathematical model that incorporates feedback phenomena. Casual loop diagrams can be used to illustrate the feedback effect. A promising area of research is to investigate the application of multi-period newsvendor more for capacity allocations in the MHS. In this work we assumed that the portion of patients that switch from MHSP to the ED is related to behavioural and contextual factors. We did not include those factors in the model and assumed that r is a constant. Future studies can include representing r as a function of time, risk behaviour, stigma, the amount of information, and other related variables. A combination of two variables can be included. Modelling a separate part of the ED for mental healthcare or special cases would also

be motivating. We used estimates of demand for urban and suburban areas to illustrate how locational factors impact policy decisions. The same methodology can be used with areas of different demand variations.

A future extension of this research can be implemented by using stock and flow diagrams to describe the influencers and the sequence of operations in the MHS. Further extensions related to knowledge transfer of the research can include simulations using Arena or similar simulation software. The work could be extended to a graphical simulation of patient switching that might include more information about different patient pathways. Special focus can be directed to youth—an important category in mental health due to increased ED utilization by youth with mental health issues. In the next essay, we will explore a vital component in healthcare and mental health services, which is the quality of the delivered care including designing services that consider the needs of patients.

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Appendices

Appendix A

Notations

X_I: the capacity of the MHSP

X_E: the capacity of the emergency department for mental health (ED)

X_I^*: the capacity of the MHSP at optimal point

X_E^*: the capacity of the ED at optimal point.

S_I: the shortage cost at the MHSP

S_E: the shortage cost at the ED

h_E: the holding cost at the ED

c_I: unit per patient at the MHSP

c_E: the unit per patient at the ED

D_I: the demand at the MHSP

D_E: the demand at the ED

C_I: total cost of the MHSP

C_E: total cost of the ED

C: total cost of the MHS

C_I^*: total cost of the MHSP at optimal point

C_E^*: total cost of the ED at optimal point

C^*: total cost of the MHS at optimal point

Appendix B

Proof of Proposition 1. For the benchmark case without switching, we obtain the second

derivatives of the objective function as:

$H_{11} = h_I f_I(X_I) + S_I f_I(X_I)$, and $H_{22} = h_E f_E(X_E) + S_E f_E(X_E)$

It holds that $H_{11} > 0$, and $H_{22} > 0$

The determinant of the Hessian matrix (H) is

$$|H|=H_{11}H22 - H_{12}^2 = h_I\, f_I(X_I) + S_I f_I(X_I))(h_E f_E(X_E) + S_E f_E(X_E))>0 \qquad (A1)$$

Therefore, the expected cost function is convex in X_I for a given X_E and is convex in X_E for a given X_E. the expected cost function is also jointly convex in (X_E, X_I)

Proof of Proposition 2. For the case with switching, we obtain the second derivatives of the objective function as:

$$H22 = h_E f_E\ (X_E - R) + S_E * f_E\ (X_E - R), \text{and}$$

$$H11 = S_I\ (1-r)f_I(X_I) - r\, f_I(X_I)F_E(X_E - R)(h_E + S_E) + 2r^2(1 - F_I(X_I))^2 f_E(X_E -$$

$$R) + rS_E f_I(X_I). \qquad (A2)$$

For $H11 > 0$, the following should hold:

$$S_I\ (1-r)f_I(X_I) - r\, f_I(X_I)F_E(X_E - R)(h_E + S_E) + 2r^2(1 - F_I(X_I))^2 f_E(X_E -$$

$$R) + rS_E f_I(X_I) > 0.$$

Proof of Proposition 2. For the case with switching, we obtain the second derivatives of the objective function as:

$$H22 = h_E f_E\ (X_E - R) + S_E * f_E\ (X_E - R), \text{and}$$

$$H11 = S_I\ (1-r)f_I(X_I) - r\, f_I(X_I)F_E(X_E - R)(h_E + S_E) + 2r^2(1 - F_I(X_I))^2 f_E(X_E -$$

$$R) + rS_E f_I(X_I). \qquad (A2)$$

$$(A3)$$

Simplifying (A3) we get

$$f_I(X_I)\ (S_I\ (1-r) - r\, F_E(X_E - R)(h_E + S_E)) + 2r^2(1 - F_I(X_I))^2 f_E(X_E - R) + rS_E f_I(X_I) > 0.$$

$$(A4)$$

From (A4)

$(S_I (1 - r) f_I(X_I) - r \, F_E(X_E - R)(h_E + S_E))$. $\hspace{4cm}$ (A5)

(A5) is positive because $S_I > h_E$, $2r^2(1 - F_I(X_I))^2 f_E(X_E - R) + r S_E f_I(X_I)$ is positive, thus $H11 > 0$.

The determinant of the Hessian matrix (H) is

$|H| = H_{11} * H22 - H_{12}^2 = S_I f_I(X_I)(1 - r) - r f_I(X_I) F_E(X_E - R)(h_E + S_E) + r^2(1 -$

$F_I(X_I))^2 f_E(X_E\text{-R})) + S_E(r f_I(X_I) + f_E(X_E\text{-R})) + r^2(1 - F_I(X_I))^2 f_E(X_E - R))(h_E f_E(X_E - R))$.

$$(A6)$$

From (A6), we have:

$S_I f_I(X_I)(1 - r) - r f_I(X_I) F_E(X_E - R)(h_E + S_E) > 0$, and $r^2(1 - F_I(X_I))^2 f_E(X_E - R)) +$

$S_E(r f_I(X_I) + f_E(X_E - R)) + r^2(1 - F_I(X_I))^2 f_E(X_E - R))(h_E f_E(X_E - R)) > 0$.

$$(A7)$$

Therefore, the expected cost function is convex in X_I for a given X_E and is convex in X_E for a given X_E. The expected cost function is also jointly convex in (X_E, X_I).

The Optimal Solutions:

Let $\int_0^{X_I} f_I(D_I) dD_I = F_I(X_I)$, $\int_{X_I}^{\infty} f_I(D_I) dD_I = 1 - F_I(X_I)$, $FE(X_E) = \int_0^{X_E} f_E(D_E) dD_E$, and

$\int_{X_E}^{\infty} f_E(D_E) dD_E = 1 - FE(X_E)$.

For the benchmark case we have the first derivatives with respect to X_I, and X_E respectively as:

$c_I + \int_0^{X_I} h_I f_I(D_I) dD_I - \int_{X_I}^{\infty} S_I f_I(D_I) dD_I = 0$, and $c_E + \int_0^{X_E} h_E f_E(D_E) dD_E +$

$\int_{X_E}^{\infty} (-S_E f_E(D_E)) dD_E$.

Simplifying we obtain:

$$F_I(X_I) = \frac{S_I - C_I}{h_I + S_I} \text{ and } FE(X_E) = \frac{S_E - c_E}{h_E + S_E}.$$

Solving for X_I, and X_E, the optimal solutions are:

$$X_I^* = F^{-1}[\frac{S_I - C_I}{h_I + S_I}] \text{ and } X_E^* = F^{-1}[\frac{S_E - c_E}{h_E + S_E}].$$

Where $F_I(X_I) \sim N$, X = Normal Distribution, the optimal value for X_I is $X_I = Norm\ INV(Prop)$,

and $FE(X_E) \sim N$, X_E = Normal Distribution, the optimal value for X_E is $X_E = Norm\ INV(Prop)$.

For the case with switch, we have the first derivatives with respect to X_I, and X_E

$$H1 = c_I - S_I(1 - F_I(X_I)) + rS_I(1 - F_I(X_I)) + h_E r(\int_0^{X_E - R}(1 - F_I(X_I)))f_E(D_E)dD_E -$$

$$S_E r(\int_{X_E - R}^{\infty}(1 - F_I(X_I)))f_E(D_E)dD_E. \tag{A8}$$

$$H2 = c_E + h_E \int_0^{X_E - R} f_E(D_E)dD_E + S_E \int_{X_E - R}^{\infty} -f_E(D_E)dD_E. \tag{A9}$$

Equating (A9) to 0, and simplifying we get:

$$0 = h_E F_E(X_E - R) - S_E + S_E F_E(X_E - R)),$$

$$S_E - c_E = F_E(X_E - R)(h_E + S_E) \tag{A10}$$

Solving for X_E, we get $X_E^* = F_E^{-1}(\frac{S_E - c_E}{(h_E + S_E)}) + R,$

where $F_E(X_E) \sim N$, X_E = Normal Distribution, the optimal value for X_E is $X_E =$

$Norm\ INV(Prop)$.

Simplifying (A8), we get

$$H1 = c_I - S_I(1 - F_I(X_I)) + rS_I(1 - F_I(X_I)) + h_E \left[\int_0^{X_E - R} r (\int_{X_I}^{\infty} f_I (D_I)dD_I)f_E(D_E)dD_E\right] -$$

$$S_E \left[\int_{X_E - R}^{\infty} r (\int_{X_I}^{\infty} f_I (D_I)dD_I)f_E(D_E)dD_E)\right].$$

$$c_I = S_I(1 - r)(1 - F_I(X_I)) - r (1 - F_I(X_I))(F_E(X_E - R))(h_E + S_E) + S_E r. \tag{A11}$$

From (A11), we get

$$F_E(X_E - R) = \frac{S_E - c_E}{h_E + S_E}. \tag{A12}$$

Substituting (A12) into (A11) and simplifying, we get

$$\frac{c_I}{1-F_I(X_I)} = S_I(1-r) - r(S_E - c_E) + S_E\, r.$$

The optimal solution for $X_I : X_I{}^* = F_I^{-1}[\frac{S_I - c_I + (c_E - S_I)*r}{S_I + (c_E - S_I)*r}].$

The two optimal solutions for X_I, and X_E are $F_I^{-1}[\frac{S_I - c_I + (c_E - S_I)*r}{S_I + (c_E - S_I)*r}]$, and $F_E^{-1}(\frac{S_E - c_E}{(h_E + S_E)}) + R$

respectively.

3. Effective and Efficient Healthcare and Mental Health Services Incorporating Standardization and Individualization

3.1. Introduction

In this study we consider healthcare services (HCS) to include mental health services (MHS) and other general healthcare services. Mental health is an important part of healthcare that directly relates to human lives and impacts the economy and the health of the population. Providers of HCS aim to deliver services that meet the needs of patients, while using minimum resources (Berwick et al., 2008), but many people with health and mental health issues cannot receive services of the needed quality. Often, healthcare providers lack the right tools to address the needs of the patients. The Major components of quality in HCS are effectiveness and efficiency (Juran et al., 1999), which relate to the two important attributes of standardization and individualization (Sinsky et al., 2021). Standardization is the agreement on general standards in the delivery of HCS (Timmermans and Epstein, 2010), while individualization is the delivery of HCS tailored to the unique characteristics and needs of patients (Ansmann and Pfaff, 2017; Mannion and Exworthy, 2018). Patients evaluate the health/mental health service encounter based on the levels of standardization and individualization that meet their needs. However, the task of providing the best balance of standardization and individualization according to the needs of patients is often difficult, especially within the limited healthcare resources. The unique features of mental healthcare and its connectedness to personal, economic, and social aspects add more difficulties to the above task. To deliver the right services to the patients, personal, socio-economic, and environmental factors should be incorporated in all levels of planning health and mental health services (Colldén et al.,

2021). Operationally, frontline staff and healthcare providers need to be equipped with knowledge on how to deliver healthcare according to the needs of patients and populations (Nelson et al., 2002). At all levels of planning and delivery of HCS, it is important to accommodate the needs of patients, groups, and populations relating to standardization and individualization elements. In addition, healthcare designers should consider health service elements like the cost and quality of MHS, and the structure of service providers. The different processes in healthcare delivery should be coordinated to achieve the needed outcomes. Collaboration among mental health organizations will be further investigated in the next essay. The above-mentioned points underscore the need for comprehensive approaches when planning healthcare and mental healthcare services (Jayaraman et al., 2015; Tien and Goldschmidt-Clermont, 2009) that consider the integration of standardization and individualization (Kasiri et al., 2017; Needham, 2018), and other elements in HCS. In this study, we:

1- Investigate effectiveness and efficiency as the basic elements of quality in HCS. Within that we explore the relation between standardization, individualization and effectiveness, efficiency in HCS.

2- Construct the patient utility function and find the optimal levels of standardization and individualization to maximize patient's utility considering the factor of sensitivity to healthcare attributes.

3- Analyse the quadratic, linear and power utility functions, and investigate how the risk behaviour of patients influence healthcare planning and intervention design.

4- Develop a framework that connects standardization, individualization, patient's utility, and the total cost of HCS and find the optimal levels of standardization and individualization to minimize the total cost of HCS.

5- Propose paths to provide healthcare and mental health services with the best integration of standardization, individualization, effectiveness, and efficiency and explain the interaction among those factors.

We answer the questions:

- How do the conditions of patients determine different preferences in HCS with focus on MHS?

- Based on risk attitudes of the patients, when should healthcare designers stop allocating resources to certain HCS features? and how do patients perceive new programs and interventions?

- How do cultural and social characteristics of patients and populations impact the levels of standardization and individualization in healthcare and mental health services?

- Under what conditions does the improvement in patients' utility incur more cost in the HCS?

- What system conditions make it easier or harder to improve standardization and individualization simultaneously?

Analysing the relation between the costs in healthcare services, standardization and individualization provide insights about the impacts of patients' conditions on health/mental health decisions. This study guides general design of healthcare services and mental health services at population and patient levels. It replies to the fundamental need in healthcare/mental healthcare research to follow integrative approaches that include patient and system factors in healthcare design (Peters 2014; Peter and Gulick, 2019). Several studies have explored the utility function for the patient (Attema et al., 2013; Evers et al., 2007; Treadwell and Lenart, 1999), different concepts of effectiveness and efficiency (Basu, 2011), and individualization and standardization in HCS. To our knowledge, none combined all these elements with a focus on MHS. In section 3.2,

we conduct a literature review of HCS including the roles of different healthcare providers. Section 3.3 includes a review of standardization and individualization in HCS. The rest of the essay includes formulations of models, analysis, and conclusions.

3.2. Literature Review

3.2.1 The design and delivery of healthcare and mental health services

The process of planning and delivering healthcare and mental healthcare to patients and populations involves many stakeholders, which we will refer to as *agents*. All agents in the healthcare service delivery work to achieve the major goals of the HCS (Kwon et al., 2016). These goals are improving the health and quality of life for patients, delivering best patients' experiences, and managing the cost of HCS (Berwick et al., 2008; National Collaborating Centre for Health Public Policy, 2014; Zinkhan and Balazs, 2004). The main agents in the HCS are the government and the policymakers, the managers, the service providers and frontline staff, and the patients. The list of agents in health/mental healthcare services varies according to the healthcare context and the health political layout. Agents can include policymakers, legislators, planners, health and social care providers, patient and family representatives, advocates, communities, citizens and the media (Lora et al., 2017). Table 1 lists the roles of the main agents in planning and delivering HCS.

Table 1: The roles of main agents in HCS

Role/s	Agents	Specific Roles
(1) Planning general/public policies and programs for health/mental health[10].	*Government, policymakers, service planners*	▪ Set up basic health infrastructure and assign priorities (Kumah et al., 2016). ▪ Develop population-level metrics that inform health needs and health economic policies (Ritz, 2014) such as the need for standardization and individualization in HCS. ▪ Put HCS plans to meet the needs and uniqueness of different populations (Louis et al., 2019; Barry 2003) or groups such as children and adolescents and rural communities (Simon et al., 2001). ▪ Work to provide the needed services to patients and populations while implementing best cost management approaches.
(2) Delivering healthcare/mental healthcare to patients.	*Service providers, frontline staff, local managers*	▪ Implement plans designed by the HCS managers (Isern and Moreno, 2016). ▪ Assess the needs of different patients and deliver services with the right amount of individualization and standardization, and other attributes according to individual needs of patients (Reuben et al., 2018).

Agents in HCS make decisions (Betcheva et al., 2020) at different operational levels (Valimaki and Lantta, 2019). Decisions related to the design of healthcare/ mental health services include

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[10] https://www.nshealth.ca/about-us/plans-and-reports/health-services-planning

strategic design of health care programs and interventions as well as the operational design of the delivered services. This will be discussed in more details later in this essay.

Through the different roles, agents in the HCS aim to address the issues at hand (improving patient health/meeting patient's needs) in the best possible way (to be effective), with the lowest possible cost (to be efficient) (de Vries and Huijsman, 2011; Meijboom et al., 2011). Next, we elaborate on the concepts of effectiveness and efficiency in HCS.

3.2.2 Effectiveness and efficiency in healthcare/mental health services

Effectiveness in HCS describes the extent to which needed enhancements in healthcare are achieved (Donabedian, 1996, 2003). Effectiveness includes features of proper treatment and assessment (Allen-Duck et al., 2017) and elements focused on patients' care. Efficiency in HCS is associated with achieving the needed health outcomes with the best management of resources (Greenberg and Kennedy, 2014). Donabedian (2003) defines efficiency in HCS as the ability to manage the cost of healthcare while achieving the desired health benefits. Efficiency can be expressed as the ratio of the healthcare outputs or objectives to the minimum resources that are used to deliver these objectives (Lo Storto and Goncharuk, 2017).

Effectiveness and efficiency relate to each other and interact with other components in the HCS in different ways (Bayne et al., 2017; Frøkjaer et al., 2000). Often in healhtcare, the increase in effeciveness comes with a decrease in effeciency, but there are conditions that allow increasing both simulantanously. Some scholars state that effectiveness and efficiency are separate measures of quality with different characteristics (Mouzas, 2006; Niavis and Tsiotas, 2019; Williams et al., 2008). Others see that effectiveness in HCS contradicts efficiency (Butala, 2010). While Bartuseviciene and Sakalyte (2013), and Zokaei and Simons (2006) view the relation between

effectiveness and efficiency as a connected spectrum. Similarly, we view the relation between effectiveness and efficiency in an integrated way in that they complement and relate to each other. We think that both effectiveness and efficiency are important in healthcare services. For best outcomes, healthcare services should have the best balance of effectiveness and efficiency considering patients' medical, social, and other conditions (Foster et al., 2010). This is not an easy task. Coordinating between effectiveness and efficiency in HCS comes with many challenges. To aid in understanding how effectiveness and efficiency interact with patients' and HCS related factors, we analyse the major attributes of effectiveness and efficiency, namely standardization and individualization. Standardization and individualization are more noticeable by patients when they are receiving healthcare services (Godfrey et al., 2003). Patients rate their experience with a healthcare facility based on the availability of the right amounts of standardization and individualization according to their preferences and needs.

3.3. Standardization and Individualization in Healthcare/ mental health Services

3.3.1 Description of standardization and individualization

Standardization and individualization are main components of quality in healthcare/mental health services (Colldén et al., 2021; Juran and Godfrey, 1999). Standardization in the HCS (Q_s) relates to the development and application of structured methods and technical specification in the delivery of healthcare and mental health services (Leotsakos et al., 2014). Examples of the application of standardization are evidence-based approaches in general health (Barratt, 2008) and mental healthcare (R. Friedman and Drews, 2005). Other examples of standardization in mental healthcare are disease management methods used in treating chronic mental healht conditions such as depression (Neumeyer-Gromen et al., 2004; Simon et al., 2001). Standardization also includes

process, safety, and operations standards in healthcare (Izadi et al., 2017) such as following procedural guidelines in the registration procedures for HCS.

Individualization in HCS (Q_i) relates to the design of healthcare services according to the different biological, psychological, social, and other dimensions of patients (Ansmann and Pfaff, 2017). Examples of individualization methods are case management approaches that are used in general healthcare (Reid et al., 2009) and in mental healthcare (Weingarten et al., 2002). Individualization can include the personal attention and time given by the doctor to the patient, addressing the needs of patients according to demographic differences such as age and other personalized elements. Like standardization, individualization includes medical aspects, processes, operations, and other aspects of healthcare services.

Both standardization and individualization are important in healthcare/mental health services (Ansmann and Pfaff, 2017). Benefits of standardization include reduction of cost of HCS (Lewis, 2005; Rozich et al., 2004), reduction of errors, time saving, and providing measures of evaluation healthcare services (Kendall and Flannery-Schroeder, 1998). Individualization aids in delivering better health outcomes and improves patient adherence (Bond et al., 2009; Kasiri et al., 2017; Lampel and Mintzberg, 1996). Patients evaluate the experience with the health service provider according to the availability of standardization and individualization methods that meet their needs and preferences (Ansmann and Pfaff, 2017). Personal choices, health conditions, social conditions and other factors shape patients' preferences for individualization and standardization (Maples et al., 2022). For example, a patient might rate a visit to a medical clinic according to the way a doctor addresses concerns, asks questions, gives more time, addresses unique physical and mental needs of the patient (individualization). The patient also evaluates elements such as the process of admission, good use of time, the nurse taking vital signs (standardization). It is important to note that many mental heath services require more individualizing due to the distinct nature of mental

health needs, and the strong connection with personal factors (Bonds et al., 2009). Nonetheless, areas of general awareness and services that deal with more moderate mental health issues might have more standardization than individualization. In the next section, we will explain the relation between standardization/individualization and effectiveness/efficiency to aid our analysis on how these factors articulate in the HCS.

3.3.2 Standardization, individualization and effectiveness, efficiency in healthcare services

The proper application of standardization in HCS improves the efficiency of healthcare services (K. G. Friedman and Fulton, 2016; Guzman et al., 2015). For example, standard pathways provide treatment guidelines (Ralston et al., 2016) which reduce time and/or costs of treating common medical cases (Luborsky and DeRubeis, 1984; Mannion and Exworthy, 2018; Sackett et al., 1996). Similarly, following standard procedures in the admission process for medical visits improves the utilization of time and increases the efficiency of the process (Dayal and Alvarez, 2015). The relation between standardization and efficiency can be expressed as:

$$ef \propto Q_s \qquad (1)$$

where Q_s is the level of standardization in the healthcare services, ef is the efficiency of HCS, and $\propto$ represents positive proportion.

The relation above can be written as:

$$ef = f(x) \, Q_s \qquad (2)$$

where x is a variable related to the correct implementation of standardization or the effectiveness of standardization methods. The form of the function $f(x)$ depends on how standardization is correlated to efficiency. In this study we will assume that $f(x) = g$, where g is a constant that resembles the implementation of standardization approaches. We assume that the approaches of standardization are rightly designed and applied.

Individualization is mainly related to improvements in the effectiveness of HCS (Humburg and Collins, 2010). When the needs of the patients are addressed, patients adhere to the treatment better and it will be more successful (Ansmann and Pfaff, 2017; Pfaff et al., 2010). The relation between individualization and effectiveness can be expressed as:

$$ev \propto Q_i \qquad (3)$$

where Q_i is the level of individualization in healthcare services, ev is the effectiveness of HCS, and $\propto$ represents positive proportion. Eq. (3) can be written as:

$$ev = f(y) \, Q_i \qquad (4)$$

Where $f(y)$ is a function related to the right implementation of individualization. Similar to standardization, we assume direct proportion, and the right application of individualization and let $f(y) = g_1$.

We will not discuss how to determine the levels of effectiveness and efficiency in healthcare services in this study. Our focus is on how those two factors can be best integrated in HCS. Over the longer term of healthcare delivery, multiple and weaker relations can be seen between individualization, standardization and effectiveness, efficiency. An increase in individualization mainly improves effectiveness (as discussed) and improves efficiency in the longer term, but to a

lesser degree (Basu and Meltzer, 2007); better outcomes prevent repeated visits (Needham, 2018). Similarly, standardization mainly improves efficiency, but it also improves effectiveness in the longer term, but to a lesser degree (Needham, 2018). With refernce to standardization and individualziation, we represent the status of healthcare/ mental healht services by a quadrant. The delivered health service or mental health service can be in one of the four status relating to standardization and individualization represented in Figure 1.
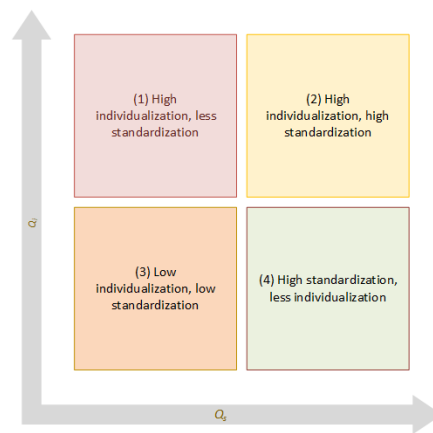

Figure 1: The status of HCS related to Q_i and Q_s

As mentioned in Table 1, a main role for healthcare planners is to set resource allocation plans to different parts of the healthcare services and facilities. For proper resource allocation in HCS, it is important for health planners to understand how patient, system, and environmental factors impact the needed levels of standardization and individualization in HCS. In the next section we construct and analyse models and develop a framework that explain the previous concepts.

3.4. Base Models

In this section we consider the following:

1) Construct the basic forms for the patient's utility function in HCS.

2) Investigate different forms of patients' utility functions for standardization and individualization in HCS and link it to patient's choices.

3) Develop the quadratic patient's utility function with trade-off factor and find the optimal levels of standardization and individualization considering patients' sensitivity to healthcare/mental health choices.

4) Develop the total cost framework for HCS and find the levels of standardization and individualization that minimize the total cost of HCS.

3.4.1. Patients' utility function

Utility is a measure of preference that expresses the preferences for different choices in measurable values (Weinstein et al., 2009). When making decisions about HCS choices, a person (patient) prefers the choice with the highest value or utility (Carreño, 2020). There are many factors that determine how patients form their choices in healthcare and mental healthcare. Cox (1982) referred to the factors that impact the patient's choice of healthcare services as the singularity of the patient. Patient's singularity includes a set of factors related to the patient and the environment. Those factors can be categorized into background factors like demographic characteristics, social characteristics, and environmental resources, and personal factors like natural motivations, and perspectives on health and health status. Sometimes, a group of patients can share some common characteristics (Minvielle et al., 2014) or preferences related to healthcare choices. The utility

function in healthcare and mental health expresses the preferences and needs of patients in mathematical form. Utility function can take different forms such as exponential, power, quadratic, linear and others (Eichner and Wagener, 2005). As in healthcare and mental healthcare, there is an amount of uncertainty; any choice in healthcare involves a certain amount of risk (Rosen et al., 2003). People behave differently in situations that involve risk. The shape of the utility function is related to the risk attitude of people in taking healthcare choices. Convex utility function is related to risk taking attitudes in healthcare, while concave utility function is related to risk averse attitudes in healthcare, and linear utility function is related to risk neutral attitudes in healthcare (Martín-Fernández et al., 2021). Factors that influence peoples' behaviours towards risk in healthcare include personal characteristics, culture (Mahlich et al., 2018), health conditions and contextual conditions (Hellinger, 1989). Studies state that people tend to be risk-averse in choosing health interventions or treatments (Belciug and Gorunescu, 2015) when they undergo, mild, chronic manageable, or moderately severe health conditions (Rouyard et al., 2018; Gafni and Torrance, 1984). While people tend to be more risk taking when they undergo more severe or critical health conditions (Gaskin et al., 1998). Other factors that impact the risk attitude of people to healthcare include information availability and trust in the healthcare organizations (Pearson and Raeke, 2000). Viscusi (2019) stated that people might be more risk averse about medical choices when they do not have enough information about their medical conditions and treatment, or they don't trust the health service provider. Patients' age (Prins et al., 2008) and perception to their own health condition (Chauhan and Campbell, 2021) also influence their risk attitude. Sometimes, mere personal factors unrelated to the health condition shape the risk attitudes of patients. In the following we will list the basic forms for the quadratic, the power, and the linear utility functions in healthcare. The base form of the quadratic utility function (Hanoch and Levy, 1970; Maillet and Jurczenko, 2006) is:

$$U = bX - aX^2 \tag{5}$$

The power utility function is:

$$U = h_1 X^\theta \tag{6}$$

The linear utility function is:

$$U = h_2 X \tag{7}$$

where, h_1, h_2, a, b and θ are constants, U is the utility for the patient, and X is the healthcare attribute. Considering N attributes in healthcare, the forms for the multiplicative and the additive utility functions are:

$$U = \prod_r^N h_3 u(Q_r) \tag{8}$$

and

$$U = \sum_r^N (w_r u(Q_r)) \tag{9}$$

where w_r is the preference a patient assigns to each healthcare attribute, and h_3 is a constant.

3.4.2 Utility functions for standardization and individualization in healthcare/mental health services.

The two attributes of interest in this work are standardization and individualization, so we set $N = 2$, let Q_i be the level of individualization in healthcare services, and Q_s be the level of standardization in healthcare services. As discussed, patients have different preferences of individualization and standardization. We substitute the attributes of standardization and individualization in the basic utility function. We set $N = 2$ in Eq. (9) to construct the additive quadratic utility functions for standardization and individualization which is represented as:

$$U(Q_i, Q_s) = w_i \left(-aQ_i^2 + mQ_i \right) + w_s \left(-bQ_s^2 + nQ_s \right). \tag{10}$$

where w_i is the patient's preference for individualization in HCS, w_s is the preference for standardization in HSC, a, b, m and n are constants. We set $N = 2$ in Eq. (8) to construct the power multiplicative utility function in terms of individualization and standardization in healthcare services which is represented as:

$$U(Q_i, Q_s) = (Q_s^m) \ (Q_i^{m-1}). \tag{11}$$

3.4.3 Utility function for standardization and individualization including sensitivity and trade-off factors.

Using the quadratic function, we construct the total utility function for standardization and individualization. In this part we include the trade-off factor between individualization and standardization, and the patient's sensitivity to individualization and standardization in HCS. We then find the optimal levels of individualization and standardization that maximize the utility function. The trade-off factor in the total utility function, (r) represents the correlation between individualization and standardization in relation to the patient's utility. Positive correlation represent conditions where standardization and individualization move in the same direction (increase or decrease) to maximize the utility of the patient. While negative correlation represent conditions where standardization and individualization move in opposite directions.

Patient's sensitivity to an attribute in healthcare/ mental health services follows the same concepts as price sensitivity in economics (Umashankar et al., 2016). Patients observe attributes in HCS in different degrees according to individual and cultural characteristics (Foster et al., 2010; Huls et al., 2022). A single patient may observe an attribute differently in two different environmental,

personal situations, or times. Some patients are more observant to features related to individualization such as communication with the doctor, than to features related to standardization such as following technical procedures (Otani & Kurz, 2004). In relation to health outcomes and costs, some patients are more sensitive to treatment outcomes than to the cost, or vise versa (Thacher et al., 2005). Sometimes patients are equality sensitive to the cost and the outcome of healthcare treatments. The method of delivering healthcare attributes influences the sensitivity of patients. For example, individualized approaches might be implemented but may not deliver the expected outcome to the patient (Costello, 2001; Suhonen et al., 2009), such as addressing the physical needs of the patient while neglecting the emotional needs. Patients' awareness of HCS attributes also influences their sensitivity (Truong et al., 2020). In the following, we explore how patients' sensitivities to standardization and individualization in HCS influence the optimal levels of standardization and individualization to maximize the total patient's utility function. We represent the total utility function for the patient including sensitivity and trade-off factors as:

$$U = w_i((\tfrac{1}{z})mQ_i - aQ_i^2) + w_s((\tfrac{1}{k})n\,Q_s - \,bQ_s^2) + r\,Q_iQ_s. \qquad (12)$$

where $(1/z)$ is the patient's sensitivity to individualization and $(1/k)$ is the patient's sensitivity to standardization. The healthcare designer must incorporate the right levels of standardization and individualization to maximize the utility for the patient. The objective is to find the levels of standardization and individualization to maximize patient's utility.

$$\underset{Q_i, Q_s}{Max}\ U(Q_i, Q_s)$$

Solution:

Proposition 1: *There exists a unique optimal solution to* $(Q_i, \; Q_s)$, *which is given by:*

$$Q_i^* = \frac{w_s(2bkmw_i - nrz)}{kz(4abw_iw_s - r^2)} \tag{13}$$

and

$$Q_s^* = \frac{w_i(2anzw_s - kmr)}{kz(4abw_iw_s - r^2)} \tag{14}$$

3.4.4 The total cost framework for individualization and standardization in healthcare services.

In this part, we develop the total framework for standardization and individualization in healthcare and mental health services. We find the optimal levels of individualization and standardization that minimize the total cost of the HCS via the total cost framework. In this part, we expand the model used in Anderson et al. (1997) in the context of service industry to develop a framework for individualization and standardization in HCS. In our model, we incorporate important variables in the healthcare context like the medical and non-medical cost of healthcare, health status of the patient, social and economic conditions, and the price a patient pays for HCS. This will provide an in-depth analysis of how those factors impact the design of healthcare and mental health services. Before developing the framework, we will discuss cost and demand factors in the HCS. This will illustrate how the framework connects to HCS planning decisions. We consider the two levels of delivering healthcare services discussed in Table 1.

a. Planning general/public policies and programs for healthcare services (strategic level)

As listed in Table 1, when planning population and general health and community programs (Schwartz et al., 2022), HCS managers set resource allocation plans to individualization and standardization elements in different healthcare services. They base their decisions on contextual factors, demographic factors, system factors and the needs of communities (Barry 2003). The allocation of resources to individualization in community mental health programs can include training of professionals to consider different population needs when delivering mental health services (Angstman 2014; Johnson et al., 2021), initiating support centres for certain groups like youth, and providing supportive technologies to provide individualized services (Johnson, et al., 2021). Allocating resources to standardization in mental healthcare involves elements like initiating standardized manuals (Committee on Data Standards for Patient Safety, 2004) and training on standards of mental healthcare like the National Standards in Mental Health Services[11]. In this work, we refer to the total funds, resources or costs directed to individualization and standardization in the strategic planning of general HCS programs as (FC). Mainly, FC is constant over the planning time horizons (e.g. yearly plans). Figure 2 represents the relation between the level of standardization, the level of individualization, and FC in the HCS.

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[11] https://www.safetyandquality.gov.au/our-work/mental-health/national-standards-in-mental-health
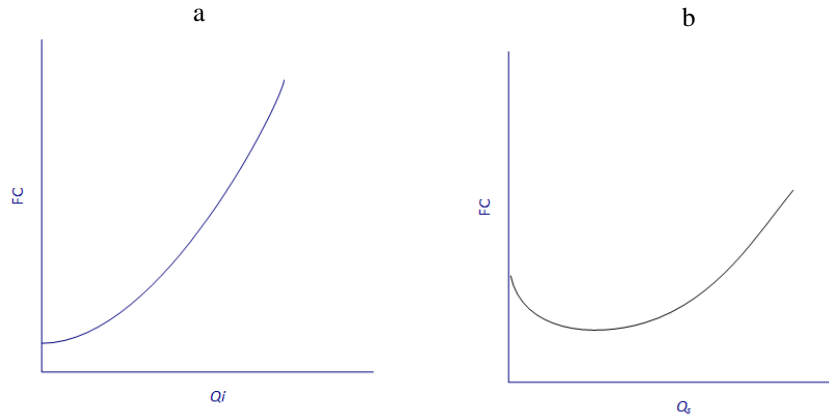
Figure 2: The change in FC and (a) level of individualization (b) level of standardization in the HCS

It can be seen that FC increases with the level of individualization because approaches that provide individualized care in HCS mainly require more cost in healthcare/mental health services (Kong et al., 2022; Mannion and Exworthy, 2018; Sinsky et al., 2021). Examples of individualized care directed to communities are mental health programs that serve groups with special needs like youth, rural population and/or elderly. The cost of individualization is represented by:

$$\frac{\lambda_i Q_i^2}{2} \tag{15}$$

where (λ_i) is the cost acceleration factor of individualization.

Relating to standardization, FC is convex resembling the dual effect of standardization on cost. Initiating standardization approaches incurs initial cost such as the cost of agreeing on and setting standards of mental health and safety procedures. Over time, the application of standardization methods in HCS has a cost reduction effect with diminishing returns (Anderson et al., 1997; APEC, 2010; Dayal and Alvarez, 2015; Polo-Redondo and Cambra-Fierro, 2008). The cost of standardization in the planning of HCS is represented by:

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$$- \delta_s Q_s + \frac{\lambda_s Q_s^2}{2} \tag{16}$$

where (δ_s) is the cost saving effect of standardization and (λ_s) is the cost acceleration factor of standardization in the HCS. For standardization to influence cost saving, the initial investment in standardization should not exceed the estimated cost of errors (Polo-Redondo and Cambra-Fierro, 2008; Anderson 1997). The benefits of standardization in cost reduction should be less than the cost of initiating standardization.

The total cost for standardization and individualization (Anderson et al., 1997; Khouja and Robbins, 2003) in the strategic level of planning HCS is:

$$FC = -\delta_s Q_s + \frac{\lambda_s Q_s^2}{2} + \frac{\lambda_i Q_i^2}{2} + \gamma Q_s Q_i \tag{17}$$

Where (γ) is the trade-off factor of standardization and individualization relating to the FC. The factor γ represents the correlation between individualization and standardization in healthcare services in the cost function. Positive correlation between individualization and standardization relates to conditions where they can be improved simultaneously without incurring high costs in HCS.

b. Delivering healthcare/mental healthcare to patients (operational level).

In reference to Table 1, the local management, frontline staff, including medical staff (doctors/nurses) work to deliver healthcare services to patients with the right levels of individualization and standardization after assessing patients' needs and conditions (Reuben and Sinsky, 2018). In healthcare/mental health delivery in clinics and other healthcare facilities, there is a unit cost associated with each patient's visit to a healthcare provider. In this study we represent

this cost by the parameter (c). The parameter c represents the average healthcare/mental health service cost per visit to the healthcare provider (unit cost). In public health, the physician submits a claim to the government, and receives the cost of care they provide. The cost of a services that a physician delivers is equal to the professional fee or tariff paid to a physician for the service provided[12]. In private healthcare like private counselling clinics or similar services, the health provider (doctor, therapist, private hospitals, and others) pays for the healthcare services directly. The average unit cost of health/mental health services differs according to the health/mental health conditions of patients and the context; more critical cases health/mental health incur higher costs. Patients can be categorized according to similar characteristics, health conditions and associated costs of health services. The classification of patients into groups of similar characteristics/needs supports healthcare and mental health planning. Other factors that influence the cost of healthcare services include locational and economic factors. For example, it is more expensive to hire staff in some areas than in others. The cost of rent and facilities can differ according to locations. In essay 1, we investigated how locational factors impact capacity decisions in mental health services.

In this study, we will express the visits to a healthcare/mental healthcare provider as the demand for healthcare/ mental health services. If we set D to represent the average demand for healthcare/mental services, which is the healthcare visits. Then the total cost of patients attending HCS in a certain time is $c.D$. Like Anderson et al. (1997), Naidu (2009), and Platonova and Shewchuk (2008), we go with the assumption that the demand for healthcare services increases with patient's satisfaction (utility) and decreases with the price a patient pays to receive the healthcare service. Also factors like personal preferences, recommendations or word of mouth influence the demand for healthcare/mental health services. When going to and receiving

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[12] http://mchp-appserv.cpe.umanitoba.ca/viewConcept.php?printer=Y&conceptID=1354#a_references

healthcare services, patients pay a certain price, p. This can be the direct price or indirect price such as the cost of time and/or travel cost. It should be noted that not all mental health services in Canada are free. For example, patients can pay part of the cost for insured mental health counselling services. At times, patients can pay all the cost for counselling services if they do not have insurance. The price patients pay (p) differs according to the status of insurance, health condition, location and other patient related conditions. The demand for healthcare/mental health services can be represented as a function of the patient's utility and the price a patient pays for healthcare:

$$D = f(U(Q_i, Q_s), p). \tag{18}$$

As indicated, we express the patient utility in terms of standardization and individualization. Thus Eq. (18) can be written as:

$$D = \alpha \left(U(Q_i, Q_s) p^{-\left(\frac{1}{\beta}\right)} \right). \tag{19}$$

where α is a constant related to personal preferences of the patient, p is the price a patient pays to receive healthcare services, the factor $(1/\beta)$ is the weight of (p) on the patient. We assume that the burden or the weight of p on the patient increase with socio -economic challenges. We will discuss this factor in more detail in later sections. From (a) and (b), the total cost of the demand, standardization, and individualization in healthcare/mental health services can be represented by:

$$C = c.D + \left[-\delta_s Q_s + \frac{\lambda_s Q_s^2}{2} + \frac{\lambda_i Q_i^2}{2} + \gamma Q_s Q_i \right]. \tag{20}$$

By substituting Eq. (19) in Eq. (20), the total cost for healthcare/mental healthcare services is:

$$C = c.\alpha(U(Q_i, Q_s) * p^{-(1/\beta)}) + \left[-\delta_s Q_s + \frac{\lambda_s Q_s^2}{2} + \frac{\lambda_i Q_i^2}{2} + \gamma Q_s Q_i \right]. \tag{21}$$

In this part we used the linear form of the utility function for individualization and standardization. The linear utility function represents conditions of risk neutrality. It has been used in many

applications related to community healthcare decision-making (Stinell and Paltiel, 1997; Cher et al., 1997) and approximates a wide range of utility functions. The total cost framework for health/mental health services is:

$$C = c.\alpha.[w_s Q_s + w_i Q_i](p^{-(1/\beta)}) + [-\delta_s Q_s + \frac{\lambda_s Q_s^2}{2} + \frac{\lambda_i Q_i^2}{2} + \gamma Q_s Q_i] \qquad (22)$$

Notations are in Appendix1. The objective is to find the levels of individualization and standardization that minimize the total cost of the HCS:

$$\underset{Q_i, Q_s}{Min} C(Q_i, Q_s)$$

In finding the optimal solution, the following propositions holds:

Proposition 2*: There exists a unique optimal solution to* (Q_i, Q_s)*, which is given by:*

$$Q_i^* = \frac{\alpha c p^{-(1/\beta)}(\gamma w_s - w_i \lambda_s) - \delta_s \gamma}{\lambda_s \lambda_i - \gamma^2} \qquad (23)$$

and

$$Q_s^* = \frac{\alpha c p^{-(1/\beta)}(\gamma w_i - w_s \lambda_i) + \delta_s \lambda_i}{\lambda_s \lambda_i - \gamma^2} \qquad (24)$$

Proposition 3: for the optimal solution to be convex in Q_i, Q_s *the following should hold:*

$\lambda_i \lambda_s - \gamma^2 > 0$.

Proof in Appendix 3.

3. 5. Analysis

3.5.1 Patients' behaviors in healthcare services.

Analysis of risk behaviour in healthcare/mental health services

Understanding patients' healthcare choices and risk behaviour attitudes informs healthcare planners about different healthcare utilization patterns (Lutter et al., 2019; Lorian and Grisham. 2011). This aids healthcare designers in developing resource allocation plans for health and mental health service interventions (Martín-Fernández et al., 2018) by informing on what groups of patients are more likely to utilize certain healht interventions. Ericson and Sydnor (2017) and Friedman (1974) mention that risk attitudes among patients is associated with how patients accept new programs and interventions in HCS. This point is very imortant to consider when developing new programs in healhtcare and mental healhtcare. There are cases when new interventions are not accepted or utilized by patients (Barnett et al., 2018). A method to encourage the uptake of new interventions in healhcare could be the modification of risk attitudes. Research states that the utilization of mental healthcare services depend on a range of psycological, social and demogrphic factors inlcuding risk perspective (Henshaw et al., 2009), knowledge, and trust in HCS organizations. In this part, we discuss risk aversion attitude via the concave quadratic utility function (Gafni and Torrance, 1984; Rouyard et al., 2018), Figure 3. In this function, we can see that beyond a certain limit, the patient's utility starts to decrease (Mannion and Exworthy, 2018; Peer and Mpinganjira, 2011; Wagner and Bear, 2009).
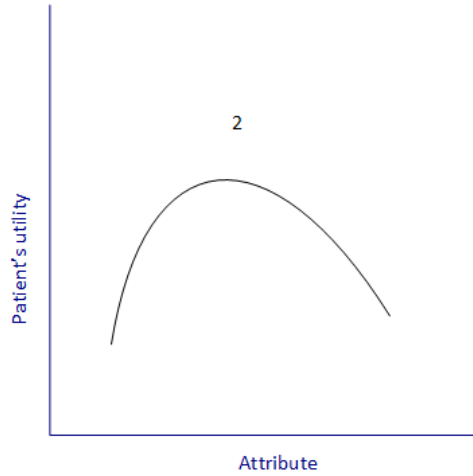
Figure 3: Concave utility function in HCS

The point where the patient utility starts to decrease, or the maximum point is referred to as the *inflection* point (Hui and Wu, 2016), labelled *2*. As will be illustrated in the following example, the location of the inflection point is related to the risk aversion attitude of patients in healthcare/mental health services. Knowing the location of the inflection point for different patients or patient groups helps healthcare planners decide when to stop allocating resources to healthcare features; beyond a certain limit increasing the levels of attributes in HCS has diminishing effect on patients' utility. For the concave quadratic utility function in Eq. (10), the following holds:

$$U_X' = \frac{\partial U_X}{\partial X} = b - 2aX. \tag{25}$$

$$U_X' => 0 \; if \; b > 2ax.$$

$$U_X'' = \frac{\partial U_X^2}{\partial X} = -2a. \tag{26}$$

From Eq. (25) we obtain the inflection point for the patient's utility function. We now analyse the patients' risk attitudes and utility function using Arrow–Pratt analysis of risk aversion (Levy and

Levy, 2002). According to Arrow–Pratt, the absolute risk aversion factor for a certain utility

function (U) is:

$$A = -\frac{U''}{U'} \tag{27}$$

The absolute risk aversion factor for U in HCS is

$$A(X) = \frac{-U''_X}{U'_X} = \frac{2a}{b - 2aX} > 0, \, b > 2Xa. \tag{28}$$

where $A(X)$ is the absolute risk aversion factor for a healthcare/mental health attribute, X. To

further explain risk behaviour in healthcare, we introduce the following scenario: Let's say we have

two patients; we refer to the first patient as $Pt1$, and the second as $Pt2$. Let the utility function for

$Pt1$ be $U_{1,X} = (-aX^2 + b1X)$, and for $Pt2$ be $U_{2,X} = (-aX^2 + b2X)$, where $U_{1,X}$ is the utility

function for the first patient and $U_{2,X}$ for the second patient. We set $b2 = 2\,b1$, and $a = 1$. We

let $b1 = 100$, then $b2 = 200$. The inflection points for the first patient, $I(Pt1) = 50$, and the

second patient, $I(Pt2) = 100$. From Eq. (28), the absolute risk aversion for $Pt1$ is $A(X_1) = \frac{2}{100 - 2X}$,

and for $Pt2$ is $A(X_2) = \frac{2}{200 - 2X}$. Thus, for a certain X, $A(X_1) > A(X_2)$. This means that patient 1

is more risk averse to healthcare/ mental health service choices than patient 2. From a behavioural

perspective, it can be said that patient 1 prefers interventions with moderate expected outcomes

and results that can be seen in shorter terms and are more certain (Huls et al., 2022). While patient

2 prefers interventions with better expected outcomes, which results can be seen in longer terms,

and might include an amount of uncertainty. Familiar interventions are generally viewed as less

uncertain by patients, while new approaches and technologies are considered more uncertain

(Johnson et al., 2021; Iribarren et al., 2021:World Health Organization, 2011). Thus, we can say

that patient 2 is more accepting to new programs or approaches in healthcare than patient 1. As

indicated, in some situations, modifying the risk behaviour of patients is useful to increase acceptance of healthcare interventions (Mahlich et al., 2018). One way is to provide the patient with knowledge and information about these approaches. It is indicated that increasing trust in the healthcare provider reduces patients' risk aversion attitudes and encourage them to use new health/mental health interventions (Henshaw et al., 2009). In relation to help seeking for mental health, it is noted that hesitation to seek treatment among patients with pathological anxiety issues is associated with social and general risk aversion orientation (Lorian and Grisham, 2011). From this we can say that establishing trust between patients and mental health providers promotes necessary help seeking behaviour and reduces stigma (Bramesfeld et al., 2007). Assessing the links between risk aversion and patients' behaviour towards healthcare choices should consider the nature of the service provided. From the above, we see that the interpretation of risk aversion is different when considering new intervention uptake than when considering help seeking attitudes. This guides the nature of the action that modifies risk aversion behaviour to improve patients' health and mental health outcomes. In the following we analyse the power utility function and determine the levels of individualization and standardization in HCS using this function.

3.5.2 Analysis of the power utility function of individualization and standardization in HCS

In this form of utility function, the patient's utility increases with the attributes in HCS (standardization and individualization). This type of utility function resembles risk seeking attitude. Referring to Eq. (11), the power utility function for standardization and individualization can be written as:

$$U(Q_i, Q_s) = Q_i^2 Q_s^3 \tag{29}$$

In this form of function, for each utility value, there is a sets of indifference curves[13]. The indifference curves resemble all the options or bundles of standardization and individualization, a patient can choose from (Zweifel 2022). Each indifference curve resembles a utility value. As long as the patient choice is located on a certain indifference curve, they gain the same utility. The middle area of the indifference curve represents equal or close levels of individualization and standardization. In mental healthcare, this relates to conditions of medium severity that require close levels of individualized elements that address the uniqueness of different patients, as well as evidence-based approaches in similar degrees (Hoagwood, 2021). The indifference curve for standardization and individualization can be seen in Figure 4
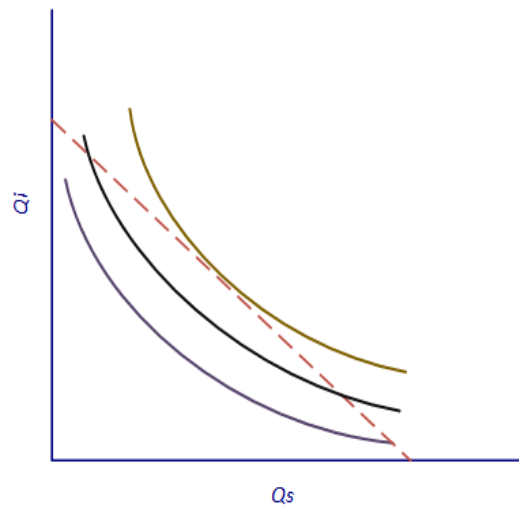

Figure 4: Indifference curve of standardization and individualization in HCS.

To further analyse the behaviour of patients towards choices of standardization and individualizing we find the marginal utilities for individualization and standardization and the marginal rate of substitution. The marginal utility for individualization is:

$$MU_{Q_i} = \frac{\partial U(Q_i, Q_s)}{\partial Q_i} = 2Q_i Q_s^3 \qquad (30)$$

The marginal utility for standardization is:

$$MU_{Q_s} = \frac{\partial U(Q_i, Q_s)}{\partial Q_s} = 3Q_s^2 Q_i^2 \qquad (31)$$

The marginal rate of substitution is:

$$MRS = -\frac{MU_{Q_i}}{MU_{Q_s}} = -\frac{2Q_s}{3Q_i} \qquad (32)$$

The marginal rate of substitution is the slope of the indifference curve, it resembles the willingness of the patient to substitute an amount of standardization for an amount of individualization in HCS. For example, if we reduce standardization level by ΔQ_s and increase individualization level by ΔQ_i, the patient will have the same utility. The rate of $\frac{\Delta Q_i}{\Delta Q_s}$ represents the rate by which a patient is willing to substitute standardization for individualization. Usually, these increments are minor and do not cause the patient's utility to move to extreme positions of the curve. Such conditions reflect medium severity health/mental health conditions in which there aren't many differences between the levels of standardization and individualization (Say et al., 2006). Mental healthcare services that address such cases are general counselling or therapy services. Primary care clinics also deal with mild mental health conditions in some cases (Hodgkinson et al., 2017; Simon et al., 2001). The patient's utility moves to extreme position of the utility curve in more severe conditions or very mild conditions. For example, cases with interrelated health issues and mental health issues

(Pfaf et al., 2010) would move the patient's utility to extreme diagonal position in Figure 4. In these conditions, patients would prefer and need high levels of individualization. While, providing general awareness services would include higher levels of standardization than individualization, which moves the utility point to the right of the curve. Many of healthcare/mental services that target a range of mild and medium severity cases, can contain higher level of standardization than individualization (EPU 2017).

The knowledge of the marginal rate of substitution can be used to reflect the flexibility of patient/s utility specially when designing programs for groups or populations. To illustrate how patient's preferences, and resource constraints impact the patient's choice, we examine the case with constraints and how that effects the total levels of individualization and standardization. Within that, we find the point that maximizes the patient's utility. Naturally, in healthcare and mental healthcare, there are financial, locational and capacity constraints (Zweifel 2022). We express the constraints on individualization and standardization of HCS as follows:

$$v_i Q_i + v_s Q_s = L \qquad (33)$$

where v_i is the level of importance or value of individualization for the patient, v_s is the level of importance or value of standardization for the patient, and L is the maximum level of individualization and standardization that can be achieved in the healthcare/mental health service. The parameters v_i and v_s are parallel to the willingness of a customer to pay a price for a certain service in economics. They can also be interpreted as the willingness of a patient to pay, or give value to a healthcare attribute. That could be how much a patient might give time, or money if they get a unit of that attribute. In healthcare, the willingness to pay (WTP) approach have been used to measure patients' preferences for treatments or factors in healthcare services (Wolf et al., 2010).

Another approach is the discrete choice experiments (DCEs) which determines patients, evaluations of different healthcare attributes (Zweifel 2021). From Eq. (32), the marginal rate of substitution can be re written as:

$$MRS = \frac{v_i}{v_s} \tag{34}$$

From Eqs. (33) and (35) we have:

$$\frac{v_i}{v_s} = \frac{2Q_s}{3Q_i} \tag{35}$$

The optimal point of (Q_i, Q_s) that achieves the maximum utility for the patient is the intersection between the MRS and the indifference curve with the highest utility as illustrated in Figure 4. This point represents the levels of standardization and individualization that maximize the utility of the patient in the HCS. In the following we will discuss the impact of factors related to the patient and the healthcare services on the choice of individualization and standardization that minimize the total cost of HCS via the total cost framework.

3.5.3 The impact of patients' socio-economic conditions on HCS decisions

We let the factor β represents social and economic conditions related to the patient in the HCS. In this study, the factor β is scaled from 1 to 5 with increased severity. We analyse the impact of β on the levels of individualization and standardization that minimize the total cost of the HCS in the total cost framework.

From Eqs. (23) and (24) we have $Q_i^* = \frac{\alpha c p^{-(1/\beta)}(\gamma w_s - w_i \lambda_s) - \delta_s \gamma}{\lambda_s \lambda_i - \gamma^2}$, and $Q_s^* = \frac{\alpha c p^{-(1/\beta)}(\gamma w_i - w_s \lambda_i) + \delta_s \lambda_i}{\lambda_s \lambda_i - \gamma^2}$.

To simplify, we let $M = p^{-(1/\beta)}$.

With reference to Appendix 4, $\frac{\partial Q_i^*}{\partial M} > 0$ when $\gamma w_s > \lambda_s w_i$ which is true for many cases.

This means that the individualization level in healthcare/mental health services need to be increased with M, M increases with β, Q_i^* increase with β. Thus with increasing β the level of individualization in HCS needs to be more. Research shows that challenging social and economical conditions negatively impact the mental health for patients (McEwen and Getz 2012) and calls for specialized mental health services. At the same time, mental health service providers try to manage the cost of the delivered services in the best way while replying to the needs of patients. As discussed, providing the right level of standardization helps to manage the cost of the mental health services. At times managers must increase standardization in the mental health services to achieve the needed cost management. Often increasing both individualization and standardization result in conflicts when achieving the cost minimization objectives. We will discuss this situation in the numerical analysis and the discussion sections.

Increasing individualization in the mental health services for patients with socio-economic challenges can include approaches such as more time, private sessions, comprehensive and coordinated team-based care (Hodgkinson et al., 2017), coordination with social and community services, and others. The coordination between mental health services and supportive community services such as housing and employment also present other forms of individualization in mental healthcare services directed to groups with challenging mental health conditions. In essay 3 we discus how such coordination can be established. In the following section we present numerical studies of how different factors in the HCS impact the levels and directions of individualization and standardization in healthcare and mental heath services.

3.6 Numerical Studies

3.6.1 Impact of patient's sensitivity on the optimal levels of individualization and standardization in the quadratic utility function.

In this part, we will analyse how the sensitivity of the patient to standardization and individualization in mental health services impact the optimal decisions to maximize the utility function considering the quadratic utility function.

From Eqs. (14) and (15) we have $Q_i^* = \frac{w_s(nrz - 2bkmw_i)}{kz(r^2 - 4abw_iw_s)}$ and $Q_s^* = \frac{w_i(kmr - 2anzw_s)}{kz(r^2 - 4abw_iw_s)}$.

We let $n = m$, and $w_i = w_s = 0.5$. We set $a = 1$, $b = 1$, $n = 100, m = 100$, $r = 2$, $z = 0.17$, $w_i = 0.5$, $w_s = 0.5$, and let k vary from 0.1 to 0.3. Figure 5 represents the impact of patient's sensitivity on the optimal levels of standardization and individualization in HCS to maximize the patient's utility.
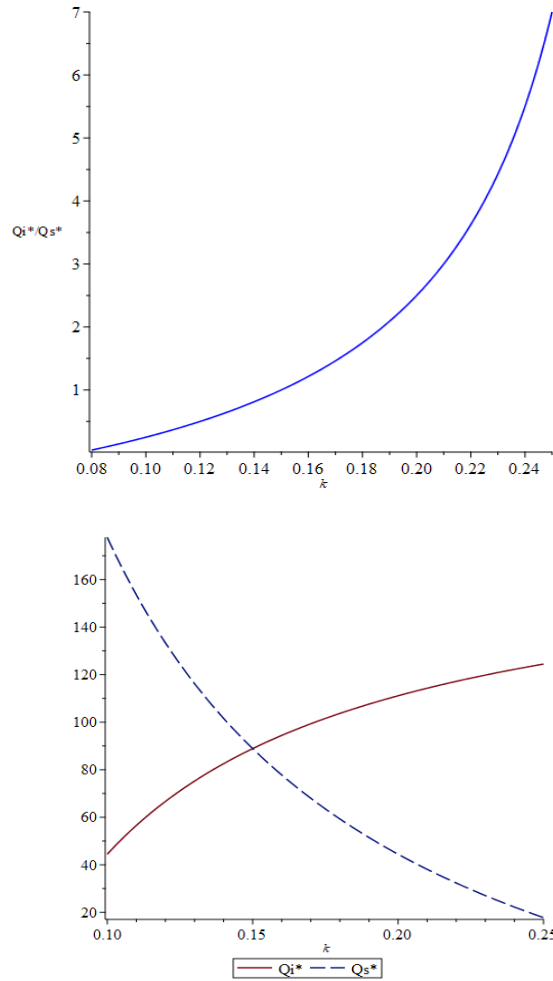
Figure 5: The relation between sensitivity, Q_i^* and Q_i^*

From the figure, we can see that when the patient is more sensitive to standardization than to individualization in the HCS, there needs to be a higher level of standardization to maximize the patient's utility. When the sensitivity to standardization and the sensitivity to individualization in the healthcare/mental health services are equal, the HCS provider should provide equal levels of both to maximize patient's utility. While when the sensitivity of the patient to individualization is more, HCS should provide a higher level of individualization. The later is related to situations when patients are more sensitive to features such as the communication, the way their concerns are addressed, and how they are treated in mental health services. A German study showed that

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health/mental health elderly patients were especially sensitive to how the healthcare provider communicates and responds to their concerns (Bramesfeld et al., 2007). The ratio of individualization to standardization in HCS increase with decreasing patients' sensitivity to standardization. This is rational because as k decreases, patients would prefer less standardization in HCS.

In Figure 6 we demonstrate how the trade-off factor influences the difference between standardization and individualization in HCS. The trade-off between individualization and standardization relates to the direction of increments or decrements in standardization and individualization in HCS. In this case, we can see that standardization and individualization are negatively correlated, when one increases the other decreases. The trade-off factor in the patient utility influences the absolute difference between the levels of standardization and individualization to maximize the utility function for a fixed patient sensitivity.
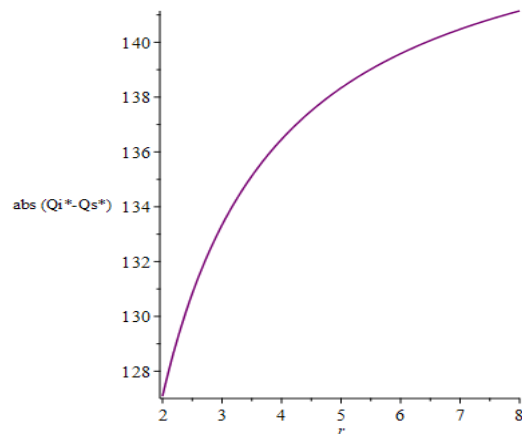

Figure 6: The relation between $|Q_i^* - Q_s^*|$ and r

From Figure 6 we can see that the absolute difference between individualization and standardization increased with r. It is more preferred to keep closer levels between standardization and individualizing in healthcare/mental health services. This will allow the healthcare provider to attain a good degree of both and attain reasonable management of the cost of healthcare while providing healthcare directed to the needs of patients (Ansmann and Pfaff, 2017). To do this, the healthcare designer should try to obtain smaller levels of r. Approaches that reduce the difficulties of applying standardization and individualization in HCS can include the application of unified patient records (Kohli and Swee-Lin Tan 2016), and having a unified register of patients' information and other applications of IT.

3.6.2 Impact of the price a patient pays on the direction of change in standardization and individualization in HCS.

As discussed earlier, the parameter p represents the average price patients pay to receive the medical care (Meltzer, 2001; Razzouk, 2017; West et al., 2010). This includes the price for medical services plus the price for non medical services such as the cost of time and travel. We assume that the price for medical services on the patient is higher than the price for non medical services. We understand that in private healthcare services, patients pay directly, while in public healhtcare services patients pay indirectly from tax money (Xiaoling and Weimin, 2011). In insured services or partially insured services, patients are reimbursed with part of the payment. Noting that not all the mental health services are public. There are some services that are insured,

and some that are not. For example, in Nova Scotia, the fee for a private-practice psychologist is $210 per clinical hour[14].

As indicated the health status, and the prefernces of patients impact the choice of the levels of standrdization and individualization in healhcare services. The price a patient pays for healhtcare and or /mental healhtcare is associated with the severity and the complexity of the health/mental health situation (McPhail 2016). In Figure 7 we show the impact of p on Q_i^* and Q_s^* in HCS via the total cost framework. We assume that a certain healhtcare service has equal levels of individualization and standardization at the current status, lets say 100. The HCS designer wants to assign the levels of individualization and standardization for a coming period for a certain mental healht program. Categorizing patients into groups of similar characteritcs such as the severity and the type of health condition, prefernces, and demographics allow healhtcare planners to plan interventions that target the characteritics of those patients (Vuik et al., 2016). We set parameters as $\lambda_s = 2$, $\lambda_i = 4$, $\gamma = 2$ $w_i = 0.4$, $w_s = 0.6$, $\delta_s = 25$, $\beta = 1$, $\alpha = 50$, $c = 100$.
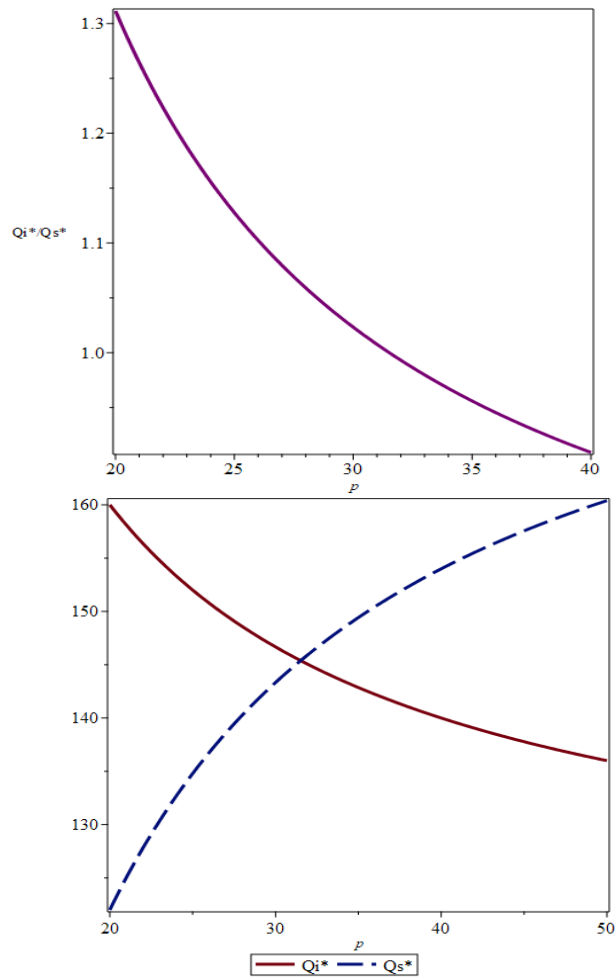
Figure 7: The relation between p and Q_i^*, Q_i^*.

We note that in this function, the objective is to minimize the total cost of HCS. The stated case represents negative correlation where the increase in one attribute comes with a reduction in the other. We can see that with increasing p, the healthcare provider should increase the level of standardization to minimize the total of HCS. As it is the benefit of the healthcare provider to reduce the cost on the patient, the healthcare provider tries to increase efficiency by increasing standardization. By this the HCS provider will gain more competitive advantage over other

providers (Gonzalez, 2019; Kong et al., 2022). This is more evident in private healthcare services where healthcare and mental healthcare providers compete to attract more patients. The healthcare provider also provides a certain level of individualization that reply to the needs of the patients. A useful strategy is that after assigning the needed level of standardization, the HCS assigns the needed level of individualization within the general standard framework (Mannion and Exworthy, 2018; Minvielle et al., 2014Wang et al., 2010). A study indicated that incorporating individualization into standardized mental health interventions for youth results in improved outcomes (Me and Weise, 2016).

In this case, individualization and standardizations are in a negatively correlated status. This means that the increase in standardization comes with a reduction in individualization. Often, it is challenging to increase individualization and standardization in the mental health care services while minimizing the total cost. Still mental health care service providers can work to create conditions where cost is managed to a reasonable degree while replying to the needs of patients as will be discussed in the conclusions. From the figure we can see that with increasing Q_i^*/Q_s^* decreases with p.

3.7 Discussions

In this study, we discussed the traits of quality in healthcare and mental health services. Understanding quality in HCS is central to provide services that reply to the needs of patients while managing the resources in HCS. As discussed, there is a critical need to develop techniques to enable healthcare providers to deliver services with the right quality. Mainly, tools to aid healthcare providers to incorporate the needs of patients in HCS, in balance with the operational requirements of HCS. Two major elements of quality in healthcare services are effectiveness and efficiency. In

this study we investigated these elements, and their dynamics in HCS. As stated, healthcare and mental health planners aim to achieve the best balance of effectiveness and efficiency in HCS, but the integration of those two elements is challenging. Mental health service planners even face more challenges due to the critical nature of mental healthcare and its various interactions with personal and social aspects. Nonetheless, there are approaches and strategies that enable reasonable integration of effectiveness and efficiency in HCS. To explore those strategies within mental HCS, we investigated the links between effectiveness/efficiency and standardization/ individualization. Standardization and individualization are more tangible elements to the patients and important factors in healthcare and mental health services. Considering those attributes, we analysed an array of factors that impact the design of HCS considering the needs and preferences of patients. To better understand patients' preferences, we constructed the patient utility function in terms of individualization and standardization and analysed different forms of utility functions. We further investigated the behaviour of patients toward healthcare choices by including the factor of sensitivity and risk attitudes. Within the utility function, we determined the optimal levels of standardization and individualization to maximize the utility of the patient in relation to patients' sensitivity and trade-off factors. We discussed how individualization and standardization relate in HCS and how to achieve the best possible balance of those two factors. Linking systems and patient factors in the healthcare/mental healthcare services, we formulated the total cost framework. Using this framework, we demonstrated operational and strategic planning strategies. Mainly how individualization and standardization levels are assigned and how that impacts the cost of HCS. We determined the levels of individualization and standardization that minimize the total cost of the healthcare services. Conducting numerical and theoretical analysis, we discussed condition that impact the integration of those two factors. The models and the analysis demonstrated the complicated dynamics and several interactions in HCS and specifically in mental healthcare

services. In the following, we present policy implications and discussions of our analysis and findings.

3.7.1 Policy implications

This study provides important policy implications encompassing a range of areas including patients' behaviours in HCS, healthcare/mental health services design, cost factors, social factors and others. We will discuss the following points.

a. Patient's utility function and risk behaviour

The utility function in HCS expresses the needs and preferences of patients to features within healthcare and mental health services. Depending on the utility and other factors, patients form certain behaviours in choosing healthcare services. Because healthcare and mental healthcare is uncertain, outcomes always contain an amount of risk. An important aspect that shapes patients' behaviors is how patients deal with risk, or the risk attitude of patients. Analysing the risk behaviour of patients guides HCS planners to understand patterns of utilization among different patients and/or patient groups, and guides in resource allocation. In addition, investigating the risk attitude in HCS guides healthcare planners to understand the acceptance of new programs and interventions among patients. This informs healthcare planners on needs to modify risk attitude to encourage the uptake of new interventions. For example, providing information to patients about new mental health programs such a mobile mental health application reduces risk aversion and increases patients' acceptance of those applications. In mental healthcare risk aversion can relate to help seeking behaviour. Higher risks attitude is linked to concerns about confidentially (Lorian and Grisham,

2011) and stigma in some mental health patients. Efforts to build more trust in the mental health organizations would improve help-seeking behaviour.

b. Maximizing patients' utility function considering sensitivity factor

Studies show that relying on the experience of patients in the design of healthcare services provides more reliable outcomes (Zastowny, et al., 1995; Priebe and Miglietta, 2019). Similarly, better outcomes in mental healhtcare were associated with higher pateints' satisfaction(utility). Literature indicates that to deliver healhrcare services with the needed quality, measures of patients' satisfaction should be incorporated in all stages of the design of mental health porgrams. Other patient related factors that determine the design of healhtcare servcies are the sensetivity towards healthcare atributes and the risk attitude of patients. In this study we constrcuted the utily function incorporating patient's sensetivity to healhtcare atributes. We determined the optimal levels of individualization and standardization that maximize the utily function and conducted analysis incorporating the trade-off factor. We concluded that the increase is the senestivity to a certain healhtcare atribute directs an increase in that atribute to maximize the utilty function. A favourable condition for healhtcare providers is when patients have balanced sensetivities to healhtcare atributes. Equal patient sensetivity, makes the design of healhcare program dependant on the value a patient gives to the atributes, which reduces the complication of multiple factors. The method of implementing and delivering healhtcare atributes infleunce how patients observe those atributes. For example, individualization methods might be implemented in certain mental health services but fail to address the needs of youth in those services. In such situations, modifying implementation methods of individualization would increase the sensitivity of youth to individualization approaches in mental health services.

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In relation to the trade-off factor and coorelation among atributes, we note that it is not always possible to increase individualization and standardization simultaneously and maximize U in mental health services. However close levels of standardization and individualization can be achieved when the trad-off factor is small. As discussed, such conditions can be achieved by using IT approaches and /or innovative delivery methods in healthcare and mental healthcare.

c. Important factors in the design of healthcare/mental health services

In this part, we analyse the impact of the cost reduction factor of standardization, and socio-economic conditions of patients when assigning the optimal levels of standardization and individualization to HCS. We base our analysis on the total cost framework. We summarise our findings in the following:

- *Impact of cost reduction factor of standardization:* The cost reduction factor of standardization, δ_s is related to the type and implementation of standardization approaches in HCS. As indicated, a main benefit of applying standardized approaches in HCS is cost reduction; standardization is positively correlated with efficiency. To increase the efficiency of healthcare services, service designers are advised to seek higher level of δ_s. Freidman (2016) mentioned that standardization in healthcare is considered successful if it manages to provide better resource utilization in HCS. He suggested to measure resource utilization before and after the application of standardization methods in healthcare services. Like Freidman (2016) we think that standardization approaches in HCS like clinical standard guidelines should be evaluated and updated periodically with new evidence and changing economic context. In mental health, studies state that psychiatric

care models should include cost management tools through standardization to deliver services of the needed quality (Baker et al., 2009).

- *The impact of socio-economic factors:* We saw that the level of individualization needs to be increased with increasing the parameter that represents socio-economic factors β. As discussed, the occurrence of mental health conditions with socio-economic challenges, require more individualized care methods. McLaughlin et al. (2012) used an indicator to assess the socio-economic states (SES) in mental healthcare and stated that there is a strong connection between SES and the prevalence of mental health issues among youth. The design of mental healthcare services should especially incorporate the needs of communities and groups such as indigenous population and other ethnic and community groups that suffer from lower health status and living conditions and have a higher prevalence of mental health conditions (Committee, 2015; Daghofer and Edwards, 2009). It is indicated that applications of data analytics introduce opportunities in patient segmentation in healthcare and mental health services (Yan et al., 2018) that assist the design of mental health programs for communities. We like to note that when the objective is total cost minimization, mainly the increase of standardization and individualization simultaneously is often not feasible HCS. This can be more challenging in mental health care with its case variations and relation to personal factors. Many cases in mental healthcare require specialized individualized services and special approaches that incur higher costs. This will be discussed in the next subsection.

d. Integrating standardization and individualization in healthcare/mental health services.

The integration of standardization and individualization is a desired condition for both patients and healthcare providers (Colldén et al., 2021; Mannion and Exworthy., 2018). When conditions allow for the integration of standardization and individualization, healthcare providers can achieve the needed efficiency and effectiveness while meeting the needs of patients. As indicated, it is challenging to integrate standardization and individualization while minimizing the total cost of HCS; it is difficult to improve the effectiveness and efficiency of HCS simultaneously in many conditions. The nature of mental health in its connection to personal, social, and other related factors introduces extra challenges to balancing effectiveness and efficiency. Despite that there are certain conditions that allow for reasonable integration of standardization, effectiveness and individualization, efficiency in HCS. Table 2 below lists circumstances that impact the integration of individualization, standardization, and effectiveness/efficiency in HCS via the total cost framework.

Table 2: Conditions that impact the integration of Q_s, and Q_i, in HCS

Patient preferences	Improve U	Correlation	U	C	(ef) and (ev)
$w_s > w_i$	Increase Q_s	Negative	$U\uparrow$	$C\downarrow$	*Increase efficiency*
	Increase Q_s	Positive	$U\uparrow$	$C\downarrow$	*Increase efficiency and effectiveness*
$w_i > w_s$ or $w_i = w_s$	Increase Q_i	Negative	$U\uparrow$	$C\uparrow$	*Increase effectiveness*
	Increase Q_i	Positive	$U\uparrow$	C does not increase	*Increase effectiveness and manages efficiency*

The green rows represent conditions that allow HSC providers to improve the utility of the patient while managing the total cost of the HCS. The first and second rows relate to situations when the patient prefers higher levels of standardization than individualization. This relates to mild health/mental health conditions, awareness, and early prevention services that require more general and standardized services. In some cases, patients might prefer less individualized approaches (Timmermans and Epstein, 2010) due to personal choices.

The third and fourth rows describe situations when patients prefer/need higher levels of individualization than standardization in HCS. Mainly, this is related to special health, social and other condition as illustrated. Also, when patients have more than one mental health issue or when mental health issues are combined with general health and or with socio- economic

issues. Often, the increase in individualization in HCS comes with extra cost. Such that increasing the effectiveness in HCS usually reduces the efficiency in HCS. However, synchronized improvement in effectiveness/individualization and efficiency/standardization in HCS can be attained with supportive methods. The application of IT, artificial intelligence, and machine learning support individualized approaches in mental health services with reasonable cost (Graham et al., 2019). The application of individualized standardization methods allows healthcare provider to offer individualization (patient-physician interaction) in a standardized framework (Mannion and Exworthy, 2018).

Importantly, all decisions in HCS should be based on assessments of patients needs and preferences. This can be done by approaches like data analytics, big data, case studies, interviews, and other evidence-based methods. Understanding the common needs of groups of patients in relation to demographic and social characteristics allows designing integrated care models for health and mental heath (Engstrom et al.., 2021). It is equally essential to conduct costs-benefit assessment of individualization and standardization techniques when planning health services to determine the efficiency of the used methods.

3.7.2. Directions for future research

In this study, we assume a common case of the behaviour of agents in HCS; agents' actions are driven by their interest and objective to provide the best care to patients. Future research can discuss contradictions in some of the objectives for agents in the HCS. Relating to patient's risk attitude, future research can consider developing models that link risk attitude and its antecedents with healthcare utilization choices. An area for future research is to consider different relations between standardization/individualization and effectiveness/efficiency like non-linear forms and

discuss factors that might impact those relations. An interesting path for future work is to apply artificial intelligence methods like fuzzy algorithms to create models for health service design. Research can include forming a matrix of important factors and their degree of influence on health program design. A promising extension of this research would be to study pathways of patients, especially youth and minorities. More research is needed to address critical gaps in our knowledge of young people's pathways to HCS. This includes responses of underserved groups such as indigenous youth, youth in protection/welfare systems, and homeless youth (MacDonald et al., 2018). The coordination between mental health services is essential to delivering services that meet the triple aim stated by the world's health organization. This is improving the experience of patients, improving the health of the population, and managing the cost of healthcare services. In the next essay we will explore collaboration between mental health organization and develop conceptual tools to enhance coordination among mental health organizations.

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Appendices

Appendix 1

<div align="center">The notations of the standardization and individualization model</div>

Variable	Definition
Q_s	Level of standardization in the HCS
Q_i	Level of individualization in the HCS
λ_s	Cost acceleration factor of standardization in the HCS, $\lambda_s > 0$
λ_i	Cost acceleration factor of individualization in the HCS, $\lambda_i > 0$
δ_s	The linear effect of standardization on cost reduction in the HCS, $\delta_s > 0$
C	The total cost of HCS
c	The cost directed of HCS per patient
p	The price a patient pays for HCS.
β	The weight or the impact of (p), from 1 to 10
h	The health status of the patient
w_i	Patient's needs or preferences of individualization.
w_s	Patient's needs or preferences of standardization.
γ	The trade-off factor between standardization and individualization relating to the total cost in the HCS, $-\infty < \gamma < \infty$
r	The trade-off factor between standardization and individualization relating to the total utility in the HCS, $-\infty < \gamma < \infty$
$1/z$	The patient sensitivity to individualization in the utility function in the HCS.
$1/k$	The patient sensitivity to standardization in the utility function in the HCS.

Appendix 2

From (15) we have $U = w_i((\frac{1}{z})mQ_i - aQ_i^2) + w_s((\frac{1}{k})nQ_s - bQ_s^2) - rQ_iQ_s$

The presence of optimal point: Deriving U with respect to Q_i, and Q_s we have:

$$U'_{Q_i} = \frac{\partial U}{\partial(Q_i)} = w_i(\frac{m}{z} - 2aQ_i) - r\,Q_s \qquad \text{A1}$$

$$U'_{Q_s} = \frac{\partial U}{\partial(Q_s)} = w_s(\frac{n}{k} - 2bQ_s) - rQ_i \qquad \text{A2}$$

Solving A1 and A2 simultaneously, we have:

$$Q_i^* = \frac{w_s(2bkmw_i + nrz)}{kz(4abw_iw_s - r^2)}, \; and \; Q_s^* = \frac{w_i(2anzw_s + kmr)}{kz(4abw_iw_s - r^2)}$$

The optimal point to be a maximum:

The Hessian matrix (He) $= \frac{\partial U^2}{\partial(Q_i)}\frac{\partial U^2}{\partial(Q_s)} - \frac{\partial U^2}{\partial(Q_i)\partial(Q_s)}$

$\frac{\partial U^2}{\partial(Q_i)} = -2w_sa \, , \frac{\partial U^2}{\partial(Q_s)} = -2w_ib$

$\frac{\partial U^2}{\partial(Q_i)\partial(Q_i)} = -r$

He $= 4abw_iw_s - r^2$

U has a maximum in Q_i, Q_s if $4abw_iw_s - r^2 < 0$ or $4abw_iw_s < r^2$

Appendix 3

$$C = c.\,\alpha[(w_s)Q_s + w_iQ_i]p^{-(1\beta)} + [\ -\delta_sQ_s + \frac{\lambda_sQ_s^2}{2} + \frac{\lambda_iQ_i^2}{2} - \gamma Q_sQ_i\ ]$$

$$\frac{\partial C}{\partial Q_i} = c\alpha p^{-(1/\beta)}w_i + \lambda_iQ_i + \gamma Q_s = 0 \qquad\qquad A3$$

$$\frac{\partial C}{\partial Q_s} = cp^{-(1/\beta)}(w_s) - \delta_s + \lambda_sQ_s + \gamma Q_i = 0 \qquad\qquad A4$$

Solving simultaneously for Q_i, Q_s we obtain

$$Q_i^* = \frac{\alpha cp^{-(1/\beta)}(\gamma w_s - \lambda_s w_i)\quad w_i - \delta_s\gamma}{\lambda_s\lambda_i - \gamma^2} \qquad\qquad A5$$

$$Q_s^* = \frac{\alpha cp^{-(1/\beta)}(\gamma w_i - w_s\lambda_i) + \delta_s\lambda_i}{\lambda_s\lambda_i - \gamma^2} \qquad\qquad A6$$

The Hessian Matrix:

$$H11 = \frac{\partial C^2}{\partial(Q_i)} = \lambda_i,\ H22 = \frac{\partial C^2}{\partial(Q_s)} = \lambda_s,\ H12 = \frac{\partial C^2}{\partial(Q_i)\partial(Q_s)} = \gamma$$

Hessian matrix $= \frac{\partial C^2}{\partial(Q_i)}\frac{\partial C^2}{\partial(Q_s)} - \frac{\partial C^2}{\partial(Q_i)\partial(Q_s)} = \lambda_s\lambda_i - \gamma^2 > 0$

For the Hessian matrix to be positive $\lambda_s\lambda_i > \gamma^2$

Appendix 4

We have

$$Q_i^* = \frac{\alpha c p^{-(1/\beta)}(\gamma w_s - \lambda_s w_i) \quad w_i - \delta_s \gamma}{\lambda_s \lambda_i - \gamma^2} \qquad\qquad A7$$

$$Q_s^* = \frac{\alpha c p^{-(1/\beta)}(\gamma w_i - w_s \lambda_i) + \delta_s \lambda_i}{\lambda_s \lambda_i - \gamma^2} \qquad\qquad A8$$

By letting $M = p^{-(1/\beta)}$ A15 can be written as:

$$Q_i^* = \frac{\alpha c M(\gamma w_s - \lambda_s w_i) \quad w_i - \delta_s \gamma}{\lambda_s \lambda_i - \gamma^2} \qquad\qquad A9$$

Differentiating with respect to M we get

$$\frac{\partial Q_i^*}{\partial M} = \frac{c * \alpha * (\gamma w_s - \lambda_s w_i)}{\lambda_s \lambda_i - \gamma^2} \qquad\qquad A19$$

$$\frac{\partial Q_s^*}{\partial M} = \frac{c * \alpha * (\gamma w_i - \lambda_i w_s)}{\lambda_s \lambda_i - \gamma^2} \qquad\qquad A20$$

4. A Strategy for Collaboration among Mental Health Organizations towards Building Capacity and Resilience

4.1. Introduction and Motivation

Mental health (MH) organizations support the resilience, recovery, and wellbeing of people living with mental illness and those experiencing mental health challenges. They do this by delivering preventative and interventional services and programs, education, and advocacy. Most mental health organizations suffer from high limitations in capacities and resources; often, the available capacities for mental health organizations are not able to meet the demand for services. As stated by a number of mental health organizations in Nova Scotia, there is a high need to improve capacity to better serve the people and communities. Of equal importance is the need to build resilience for mental health organizations to be able to deliver the needed services in face of disruptions. Almost all government and non-government MH organizations in Canada have reported the need for strategies to improve the mental health services for patients and population with mental illnesses (Cheung at al., 2007; Chadwick et al., 2012; MHCC, 2012, 2015).

It is demonstrated that collaboration between heath/mental health organizations improves the capacity (Crisp et al., 2000; Valaitis et al., 2020), and builds more resilience (Geographical Sciences Committee Board, 2011; Haldane et al., 2021) for those organizations. Collaboration will also enable MH organizations to coordinate with other health and human service organizations such as government organizations, housing, income support, employment, and the justice system organizations (Kivimäki et al., 2020). It is indicated that developing enhanced collaboration among the diverse MH services, with government and other organizations in Canada is necessary to

deliver the best services to the population (Fleury and Mercier, 2002; Valaitis et al., 2020). For any collaboration to be successful it should be based on a thorough strategic assessment of the needs, characteristics, and objectives of the collaborative organizations. In this study, we review literature on collaboration structures in health and mental health organization, factors of successful collaboration, capacity building through collaboration, and resilience building through collaboration as well as the challenges in establishing inter-organizational collaboration. We initiate a list of the main mental health organization in Nova Scotia. Based on the review and analysis of literature, we develop a general framework for inter-organizational collaboration (IOC) among mental health organizations. Within that framework, we design and develop an original process to build capacity and support resilience through collaborative strategies. We populate the framework and process with the characteristics of mental health organizations in Nova Scotia to develop a plan for inter-organization collaboration (IOC) in Nova Scotia. The designed structure sets paths for MH organizations to work together effectively and efficiently to provide the needed services for the population. The research develops guidelines to bring stakeholders in mental healthcare together by forming coordination and collaborative partnerships. This study is motivated by the expressed need to establish a successful collaboration among mental heath organizations in Nova Scotia to build capacity and resilience. An extension of this work is a pilot partnership in Nova Scotia that will be implemented using the proposed process. Our research results guide in conducting a comprehensive intersectoral analysis of MH organizations including objectives, abilities and characteristics. The deliverables can be used to achieve collaborations customized to the characteristics of different organizations in mental healthcare and healthcare. In addition, our recommendations will provide evidence-based directions that can be extended to other context in healthcare. This project will further enhance the knowledge gained at the individual and organizational level to support a larger-scale partnership in Nova Scotia and potentially the rest of

Canada. The current study focuses on Nova Scotia, where the mental health organizations are located, and the scanning of the MH organizations was conducted. We noted that there is a high diversity of mental health organizations that serve different populations like university students, seniors, immigrants and others. Such representation yields an opportunity to conduct a thorough systematic analysis of mental health organization and services. The findings provide a background for inter-organization collaboration that can be extended to regional and national demographics. The rest of the document includes a literature review, the main framework for the IOC process in healthcare, screening of MH services in Nova Scotia, a plan for IOC for mental health services in Nova Scotia, conclusions, and future directions.

4.2. Literature review

This study combines areas of organizational collaboration, mental health system, organizational processes, and strategies directed to the contextual nature of mental health services in NS. We conducted a literature review that includes inter-organization collaboration in healthcare, challenges of inter-organization collaboration, models of inter-organization collaboration, IT and organizational strategies and other related fields.

4.2.1 Inter-organizational collaboration in healthcare

A definition of inter organizations collaboration (IOC) is "a mutually beneficial process by which stakeholders or organizations work together towards a common goal" (Aunger et al., 2021; Bedwell et al., 2012; Dyer and Sing, 1998; Seaton, et al., 2018). Inter organization collaboration in healthcare is a process by which healthcare professionals and/or organizations establish a structure

for a collective objective to meet the needs of patients' and/or populations (D'Amour, 1997). It should be understood that inter organizational collaboration is a complex dynamic process inlcuding elements of common goals, resource sharing, trust and effective communications among organizations. As in (Berends and Sydow, 2019; Aunger et al., 2021) we view IOC as an interrelated and dynamic process. The collaboration structure can be evolving, new members may be included, goals may be extended, leadership and financial structure can be modified. The status of interorganizational collaboration is influenced by the social, political and the financial environments.

For organizations to provide the best services they should have the needed capacities to deliver those services to individuals and communities. Capacities for mental health organizations can be in many forms such as financial capacities, human resource capacities, community outreach capacities, knowledge and innovation capacities and others (Grant et al., 2018). In this literature we view all forms of capacities as collective. Along with capacity building, successful organizations should develop resilience to be able to operate under urgencies and disruptions.

Studies mention that many mental health organizations suffer from resources and capacity limitations amidst the increased utilization of mental health services (Lurie 2014; Moroz et al., 2020). Financial resources are very limited for these organizations, especially after the economic downturn that affected non for-profit organization (Bridgeland, 2009). Although more severe to non for-profit organizations, those economic challenges extend to most health and mental health organizations (MHCC 2015). This highlights the importance of following the best approaches in managing capacities and resources for these organizations (Eckenfelder, 2010). It has been demonstrated through many examples that collaboration among organizations aids in resource sharing. Literature indicates that collaboration is critical to the operation of health and mental

health organizations to overcome capacity limitations and enhance service delivery (Hodges 2006; Olson et al., 2011). According to Lawson (2004), the benefits of collaboration can be categorized into: benefits in effectiveness (improved results; enhanced problem-solving abilities); enhancements in efficiency (resource expansions, funding opportunities, capacity improvement, and benefits in legitimacy such as gaining more power and social support. Other scholars stressed that collaboration among health organizations enhances resource management, capacity sharing, and administrative efficiency (Eisenberg and Eschenfelder, 2000; Grant et al., 1995; Greer, 2017). The improvement of capacity sharing and planning due to collaboration can be clearly seen in organizations with complex structures and dynamic processes (Reinhardt & Keller, 2009). The complex and evolving composition of mental health organizations with their various programs and shifting context and population makes collaboration one of the best strategies to improve the operations of these organizations. In the following we will expand on capacity and resilience building in relation to collaboration among health and mental health organizations. Furthermore, we propose an initial inter organization collaboration structure among mental health organizations. We also discuss how the basic collaboration structure can be extended to include larger organizations such as other health, government and community organizations.

4.2.2 Capacity building through inter- organizational collaboration

Capacity includes but is not limited to elements like human resources, healthcare staff, facilities in various locations, financial resources, administrative and management capacity, research and development capacity (K. L. Grant et al., 2018). Through the IOC in MH organizations, resources (financial, information, skills, and others) can be shared between the collaborative organizations (Popp et al., 2014; Gulati et al., 2011). This creates a pool of joint capacities for the organizations

that can be used to serve the populations of those organizations. It is indicated that by utilization skills and experiences, organizations can leverage their individual capacities (Gray, 1985) to improve processes and operations. An example of the importance of building the needed capacities in organizations that offer mental health services and interventions can be seen in essay 1.

Capacities gained through IOC support organizations to pursue both short and long term goals (Winer and Ray, 1994), and address more complex social and health problems (Provan et al., 1995). Adding to that, the sharing of knowledge and social capital among IOC organizations act as sources of continuous learning and development (Provan et al., 2007). This is specially needed in mental health services due to the complexity of mental health and the importance of providing services to meet the needs of diverse groups.

Studies show that by collaboration, organizations can improve their capacities in different directions simultaneously (Raisch and Birkinshaw, 2008; Solis-Molina et al., 2014). This improves the factor of organizational ambidexterity. Organizational ambidexterity refers to the combined ability of an organization/organizations to improve existing capacities (serve the population) as well as improving the development and innovative capacity. It is mentioned that building collaborative relationships among health organizations helps to create ambidexterity in those organizations (Koster and van Bree, 2018; Solis-Molina et al., 2014). Organizations can integrate effectiveness and efficiency while pursuing development goals. This is related to the framework discussed in the second essay. Real evidence show how health and mental organizations are able to improve their capacities and outcomes in different directions by pursuing IOC. One of the successful examples of capacity building through IOC for mental health organizations can be seen in British Columbia in the Compass program. The Compass's objective is to build capacities for provincial service authorities to promote wellbeing and mental health for health service users. The

program incorporates the complexities of health and mental health organizations within its collaborative structure (BC Ministry of Health, 2007; Horn et al., 2015). To do this, the Compass established collaboration with stakeholders in the provincial health services authority to develop capacities for mental health promotion within healthcare services.

4.2.3 Resilience building through inter-organizational collaboration.

Resilience is defined as "the capacity of a system, community or society to adapt to disturbances and maintain an acceptable level of functioning" in hazards and disruptions (Public Safety Canada, 2019). Some of the approaches to resilience building are persevering, improving, or modifying capacities to equip organizations to provide the needed services in disruptive conditions. It should be noted that resilience can be better achieved within a group or through joint cooperation of organizations rather than individually (Public Safety Canada, 2019). This indicates that organizations need to collaborate to build joint resilience. Inter-organizational collaboration enables organizations to have more flexibility, capacity and responsiveness during disruptions, disasters, and shortages that occur suddenly (Berman et al., 2009; Haldane et al., 2021). As indicated collaboration is a dynamic evolving process with many levels of operations. Achour and Price (2010) stated that building community resilience requires sustained continuous efforts at all levels of the collaborative structure. In the following sections we discuss factors of success and challenges in building and sustaining inter-organizational collaboration.

4.2.4 Factors of success for inter-organization collaboration

The success of the collaboration initially depends on the capability of the organizations to initiate, grow, and sustain collaborative capacity towards achieving shared outcomes (Hocevar et al., 2011). When developing IOC, it is important to consider the characteristics of the members of the

collaboration as well as the interplay among the structures and processes. Readiness and willingness to participate are essential in sustaining inter-organizational collaboration in healthcare and mental health care (WHO, 1998). Participation refers to the willingness of a set of organizations and or entities to engage in the cooperative or collaborative structure (Cargo and Mercer, 2008). Those organizations can include users of mental health services, stakeholders in mental health, provides of mental health, and recipients communities. In essay 2 we discussed the roles of stakeholders in the design of mental health services. To build successful participation of IOC, the following levels of collaboration should be achieved.

(a) Cooperation within formal structures related to mental health in areas such as shared planning and decisions making within the IOC (Gardner, 2005).

(b) Continuously working among stakeholders, individuals, and community groups to address and solve important issues to the well-being of people and communities (Zakocs and Edwards, 2006).

Briefly, building effective IOC in health and mental health organizations depends on the performance of the collaboration, the coordination among partners, and the health/mental health outcomes. In other words, the ability of the IOC to achieve its stated goals. Casey (2008) stated that the main factors of successful interorganizational collaboration in nursing context are trust, partnership, change management, good leadership, shared decision making, understanding partner roles, and positive power dynamics. We will elaborate on assessment tools of inter-organizational collaboration in a later subsection.

4.2.5 Challenges in inter-organizational collaboration

Tomson and Perry (2006) identified five main challenges in establishing and sustaining inter-organizational collaboration. Some of those challenges include disagreement on governance structure and autonomy, varying norms among the organizations, and policy influences of the organizations. Common challenges in large-scale collaboration projects lie in the ability and willingness of the organizations to collaborate (Tee et al., 2019), and to continue the collaboration. During the collaboration process conflicts over goals, objectives, and autonomy (Zuckerman et al., 1995) may arise. The organizations involved can undergo a loss of identity. Different partners may have different views to solving problems and achieve goals. Misalignments in IOC relating to the structure, roles, and practices of the IOC may occur (Thomson & Perry, 2006). This is especially relevant in organizations that are not familiar with each other or in multisectoral organizations, particularly at the early stages of collaboration (Vlaar et al., 2006). Disagreement and conflicts over leadership and management may develop in different stages of the collaboration (Chandeler 2019). As indicated IOC is a dynamic process. The collaboration process may call for various stakeholders to take leadership roles at different collaborative stages which might cause conflicts with uneven power dynamics. Sometimes leaderships can be shared by more than one organization. It is understandable that building trust among organizations can take time; again, this is more difficult when organizations have not previously worked together (Popp et al., 2014).

The expenses of initiating and sustaining the collaboration is another challenge. Provan et al. (1995) stated that it is crucial to be aware of the costs and efforts needed for coordination among organizations; logistic and planning difficulties may arise. Issues related to cost and risk sharing among organizations may occur (Connelly, 2007). It is important to agree on and negotiate such matters. A common issue in inter-organization collaboration are the struggles of the organizations

to incorporate and understand method of sharing and communication (Hocevar et al., 2011). The lack of technical infrastructure and IT skills to enable collaborative work is a common obstacle to successful IOC in healthcare (Louws, 2015). Some of the challneges specific to healhtcaer are: issues of medical dominance, varying work cultures among healthcare organizations, different connections with social services, financial factors, suastianability and future funding of the organizations (Kozuch and Jurek., 2016). Organizatins sometimes face challneges in understanding the needs of individuals and communities which is a main goal in IOC (Karlsson et al,. 2020).
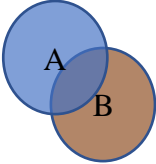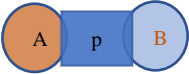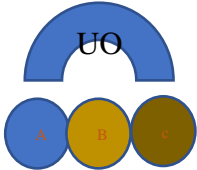
4.3. Concepts of Inter-Organization Collaboration in Healthcare/Mental healthcare

In this part we will review the structures and decision-making forms of inter-organization collaboration among health and mental health organizations.

4.3.1. Main structures of inter-organizational collaboration

To aid us in developing a strategy for IOC collaboration, we review main IOC structures. The choice of the IOC structure depends on the individual and joint characteristics of the organizations, their capabilities, and the objectives of the collaboration (Moshtari and Goncalves, 2016). As mentioned, the structure of IOC can develop or change as the collaboration grows. The main collaborations structures related to our scope are represented in Table 1; the notations, A, B, C represent different organizations.

Table 1: IOC structures

Types of collaboration	Basic features	Challenges	Structure
Partial collaboration	- Organizations keep their individual characteristics. - Smaller organizations acquire resources and capacity from larger organizations. - Larger partners share programs founded by smaller partners. - This type of collaboration eliminates service repetition and improves the efficiency of the organizations (Proulx et al., 2014). Useful to harness existing capacities.	- Smaller organizations may be dominated by larger ones. - Larger organizations are prone to more risk related to high utilization of capacities and resources (Dean, 2010).	
Joint program collaboration	- Organizations maintain their identities and autonomy in this collaboration. -Participation in shared programs may reshape some inter organizational boundaries. -Organizations share the administration of the joint programs. - This type of collaboration works best with organizations that serve similar populations and provide similar services (Blumenthal et al., 2016) such as mental health organizations that serve youth and adolescents. - Improves capacity by sharing and enables better management of resources. - Creates better impact in service delivery.	- unclarity in autonomy may create confusion in responsibilities and accountabilities. - A need to carefully assign distribution of roles of different organizations.	P- Shared programs
Confederation	- An umbrella (main) organization provides the majority of services and support to other organizations. - The levels which the umbrella organization has control vary based on the design and agreements on IOC structure. - This type of collaboration is useful in organizations that target communities with different characteristics and can be applied in collaboration or coordination across regions and /or countries. -The associate organizations must have the willingness to rely on the main organization regarding planning and capacity distribution (Proulx et al. 2014).	- Requires complex communication structures among organizations. - When the number of associate organizations exceed two, the main structure would be a collaborative network (Retrum et al., 2013). - Can face issues in representing the interests of partners in IOC strategies and decisions - More suitable for organizations that have some form of initial coordination (difficult to construct with highly fragmented organizations).	UO: Umbrella

More than one collaboration structure can be followed within IOC. For example shared partnership structure can be followed in aspects of service delivery and experience sharing and joint program structure in delivering community programs. More complicated collaboration structures include collaborative networks (Provan et al., 2007) , which are suitable to deal with highly complex and multi-layered health and social problems (Popp et al., 2014; Retrum et al., 2013). The supply chain approach in healthcare is another form of collaboration that enables health organizations to achieve their goals cooperatively (Boddy et al., 2000).   Healthcare supply chain is the collection of organizations or entities that provide healthcare or health related services to the patients (Meijboom et al., 2011). In essays 1 and 2 we conducted a comprehensive review of aspects in mental health services and organizations including structures, operations and patients' needs. The healthcare or mental decisions makers, organizations and the people they serve construct the supply chain in healthcare (Buttigieg et al., 2020; Kwon et al., 2016). Research shows that the application of supply chain approaches in healthcare settings addresses fragmentation in healthcare organizations and enables those organizations to improve the delivery of services (Christos et al., 2014; de Vries et al., 2011; Kim et al., 2015). Applying supply chain approaches to mental health organizations needs to consider the nature of mental health care, and requires certain conditions and capabilities (Rouse et al., 2019) beyond the scope of this document. In this study, we suggest that primary inter-organizational collaboration can be a supportive stage for more complex collaboration structures.

Successful collaboration should include all dimensions of the operation and the delivery of services. It is indicated that developing both horizontal and vertical partnerships in healthcare organizations enhance the capabilities of the organizations to deliver services and manage their operations (Public Health Agency of Canada 2016).   Thomas et al. (2008) indicate that the

integration of horizontal and vertical levels enables healthcare organizations to function in complex situations such as COVID 19 (Kessa et al., 2021). Within the scope of health and mental health, the horizontal dimension links the health/mental organizations with social and community organizations. While the vertical dimension links different kinds of organizations within the mental healthcare/healthcare. An example of this is the coordination among non-for-profit mental health organizations and government organizations in health or mental healthcare. We will discuss this form of collaboration in the framework session. We will also suggest paths to create future horizontal collaboration.

4.3.2 Decision-making forms in inter-organizational collaboration

The level and structure of decision making in IOC depend on the size and nature of the organizations, as well as the structure of the IOC. Two main decisions making themes are:

- Hierarchical or centralized decision making where a specific organization has most of the authority to take the main decisions. This kind of decision structure is suitable when a main organization possesses higher capabilities to define and solve problems than the other organizations (Dagger et al., 2007). This can be applied within the discussed umbrella structure. Referring to healthcare context this applies when a larger organization such as government health organizations collaborates with smaller or non-for-profit organizations.

- Flat collaboration structure where decisions are decentralized or made jointly by some or all of the organizations in the collaboration. Flat models work well when the organizations have similar competencies and capabilities (Nortey, 2018). These models may be useful in collaborating among community mental health organizations or with social organizations.

Although centralization allows faster responses and decision-making, it may be less effective to deal with complex and disruptive situations (Dynes, 2000). It is then logical to consider mixed decentralized and centralized decision approaches in IOC to achieve resilience (Geographical Sciences Committee Board, 2011). In large IOCs, leadership is not necessarily situated within any single organization hierarchy, but rather within several overlapping hierarchical structures (Connelly, 2007). In the following, we will construct a framework for developing inter organization collaboration.

4.4 A Framework for Inter-Organizational Collaboration

Based on the review and analysis of inter-organization collaboration literature in healthcare and the needs of mental health organization, we propose a framework for inter-organizational collaboration in healthcare organizations. The framework consists of a stepped process that can be applied when designing and developing IOC in healthcare. The main stages are:

1. Initiating the collaboration: The definition of the common problem/problems (the problem space) in the IOC is an essential step in initiating IOC collaboration (Zuckerman et al., 1995). The problem space can be referred to as the goal or objective space which represents the joint goals of the organizations. The organizations in the collaboration should clearly define and agree on the shared goals of the collaboration. Organization should put initial plans for primary, secondary, and short and long-term goals (Public Health Agency of Canada 2016).

2. Identify the structure of the collaboration: The collaborative organizations should choose the initial structure of the collaboration (Bolman and Deal, 2017). As indicated, the choice of collaborative structure should consider the capabilities, the context, and the objectives

of the collaboration (Heeringa et al., 2020). The size of the organizations and the nature of the delivered services also determine the structure of the collaboration.

3. <u>Develop the organizational strategy for IOC</u>: After the basic stages of initiation the IOC and identifying the main goals, organizations in the IOC should work together to construct the basic organization strategy for IOC. The organizational strategy includes the assignment of management structures, levels of engagement, roles and responsibilities of the organizations (Sanders, 2007). This stage also includes financial assessment and planning. The basic IOC strategy can be updated as the collaboration grows.

4. <u>Develop the IT strategy for IOC</u>: For any IOC to thrive, it should carefully develop an IT strategy that is compatible with the size, the structure, and the organizational strategy (Garmann -Johnsen and Eikebrokk, 2014). The IT strategy comprises of technology scope, plans, and future challenges. IT structures should also consider the financial abilities, and goals of the organizations, as well as the communication schemes between the organizations. For best operations, the IT strategy, the organizational strategy, and the objectives of the IOC should be aligned (Dairo et al., 2021).

5. <u>Delivery of functions of IOC</u>: After setting the organizational and the IT strategy, the IOC should design and agree on methods and procedures to deliver the goals of the IOC (Frank and Smith 2000). Those include frontline functions and procedures, as well as inter organizational functions and processes. The choice of the right procedures depends on the shared goals of the IOC and the communities that the IOC serve.

6. <u>Assessment of the IOC</u>: To make sure that the IOC is achieving its goals, the outcomes of the IOC should be assessed periodically (van der Schors et al., 2021). Assessing the IOC informs stakeholders on needed modifications such as updates to partnerships, new roles, adaptations to new arising goals, new methods of leaderships and others (Cropper et al.,

2009). Assessment also enables the IOC to identify lessons learnt, shortages and areas of needs.

The above steps are represented in Figure 1 including the central focus which is building capacity and resilience for mental health organizations by IOC.
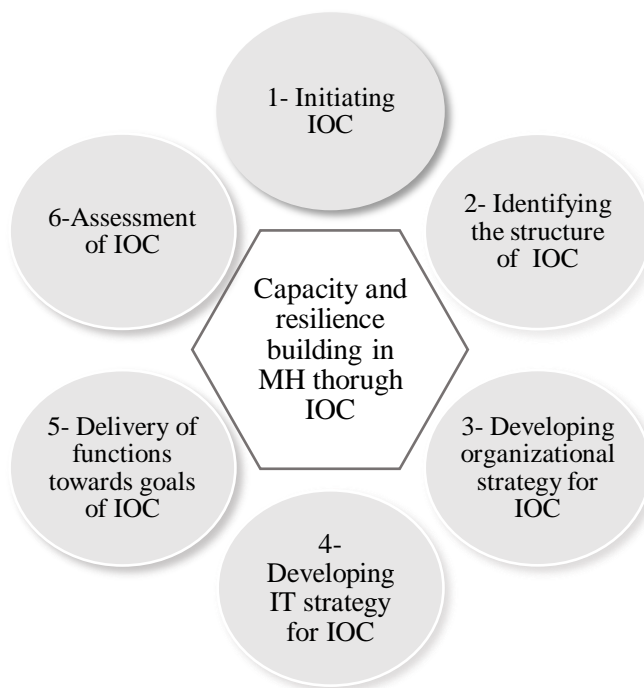
Figure 1: The main process of IOC in relation to healthcare and mental healthcare

Before developing the strategic plan for interorganizational collaboration, we conduct a screening of the main mental health and related health organizations in Nova Scotia including the services that the organizations provide, and the populations that the organizations serve. This will provide an understanding of the context of mental health organizations and their capabilities.

4.4.1. Mental health services and organizations in Nova Scotia

The Province of Nova Scotia (2019) states that "Mental health and addiction issues are a shared responsibility across a range of departments and organizations, not just the healthcare system". It indicated that improving the mental health system involves the joint work of many stakeholders, community partners, public and service providers. Appendix contains a list of the main mental health services in NS with a brief description of each organization.

4.5. A Strategic Plan for Inter-organizational Collaboration for Mental Health Organizations in Nova Scotia

In this section, we apply the process in Figure 1 to develop a strategic plan for IOC for mental health and mental health related organizations in NS. We suggest a primary collaboration of four organizations: Canadian Mental Health Association of Nova Scotia (CMHA), Laing House, Mental Health Foundation of Nova Scotia, Peer Support Groups. A students' group interested in mental health can join the collaboration for a certain time and purpose. The reasons for choosing these organizations are:

- They share the common goals that include the awareness and improvement of mental health in NS. This creates a common ground among the organizations and enables the assessment of the basic needs to improve mental health in NS.

- The experiences of the organizations are common in some areas and diverse in others. Common expertise include history working with mental health, ability to reach different communities, knowledge of mental health issues in NS, knowledge of resource and funding acquisition, and knowledge in designing and delivering mental health interventions. Diverse experiences can be seen in the various types of communities (youth, general population) these organization serve and

the different programs they offer. The combination of these experiences creates sources of shared knowledge and resources for the IOC.

- The size and the capabilities of the organization are similar. This is a suitable background for creating initial IOC with equal decision authorities and distributed roles among the organizations. We consider this choice of organizations and IOC structure as a suggested and initial example to develop and plan IOC for mental health that may include more organizations. Different organizations can be chosen with the same procedure while considering contextual and structural differences. Following are the main steps in the strategic plan for MH organizations in NS.

Step 1-Initiating: defining the problem space.

The problem space describes the main issues or objectives to be addressed by the IOC (Hocevar et al., 2011). It can include the main goals or objectives the organizations want to accomplish and/or the main issues they want to address. We apply the problem space aspect or the objective space to MH in NS (Figure 2). The problem space or the objective space in this study is represented by the dotted line. As stated, an issue that mental health organizations in NS face is the lack in capacity to reply to the needs of people. Mental health organizations in NS need to build capacity and improve resilience to function in different conditions. By this we set the objectives or goals of the IOC as: building more capacity and improving the resilience of mental health organizations in NS.
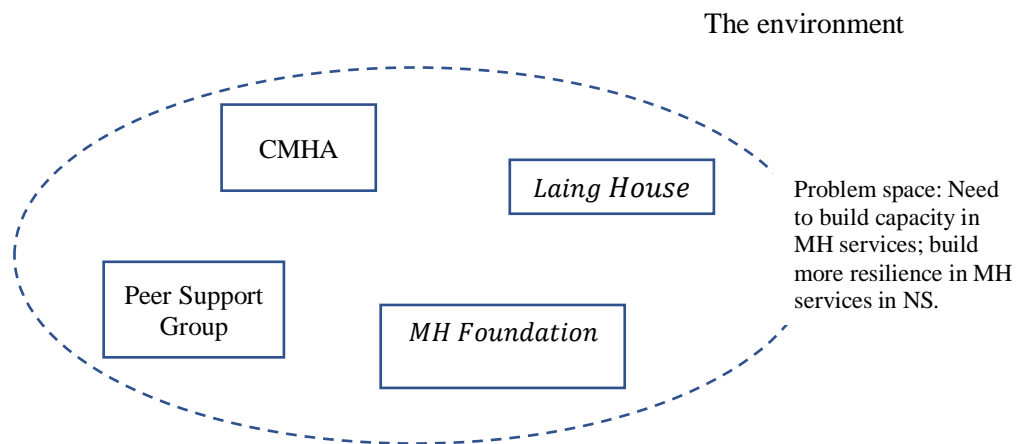
The environment

CMHA

Laing House

Problem space: Need
to build capacity in
MH services; build
more resilience in MH
services in NS.

Peer Support
Group

MH Foundation

Figure 2: The problem space for IOC for MH in Nova Scotia.

Outside the problem space is the environment and the context where the organizations exist. As indicated, the IOC evolves, and is influenced by environmental and contextual factors such as financial landscape, demographics, and policies. Those factors should be considered in the design and the implementation of the IOC (Mendel et al., 2007).

Step 2- Identifying the structure of the interorganizational collaboration.

We suggest a partial collaboration structure for the first stage of the collaboration (Table 1, number 1). This structure enables the organizations to collaborate towards achieving common goals (solving common problems), while preserving the needed autonomy and identity (Provan, 2014). This is important for the considered MH organizations that have an accumulated experience and established individual characteristics throughout their work with the communities. A suggested

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structure of collaboration between the main organizations and the smaller group is joint program collaboration structure (Table 1, number 2). For example, the students' group can join the IOC to implement a program to build capacity for university students. A different form of structure like the umbrella structure can be followed in aspects related to funding and project initiation in later stages of the collaboration. This is especially applicable when bigger organizations join the IOC in later stages such as government organizations or large hospitals.

Step 3- Developing the organizational strategy.

Authors have different definitions of organizational strategy. A general definition stated by Steensen (2013) is that strategy is the overall intended or actual themes of work or actions by the members or actors in an organization or a group of organizations. Literature indicated the importance of incorporating the complex nature of healthcare when developing strategies for healthcare organizations (Speziale, 2015). The elements in a strategic plan include the definition of the mission, vision and statement, the agreement on roles and leadership, and the action plan. In the following we will expand on the main part of the organizational strategy in relation to IOC collaboration for organizations and stakeholders in mental healthcare. We discuss the main points of identifying the governance of the IOC, assigning the main roles in the IOC and initiating the main financial plan. The following shows the suggested outlines for IOC strategy and governances.

   a- Organizational governance

Governance refers to methods of ruling or governing in an organization or an establishment (Jutla et al., 2021), or in a collaborative structure of organizations. It is stated that governance and agreeing on leadership and other roles in organizations are main steps in building trust among stakeholders and sustainability for those organizations. Bryson et al. (2006) define governance in

the collaboration between organization or collaborative governance as the collection of management and coordination activities in the IOC that are basic to the development and continuation of the IOC. In the following we review the main items of governance for IOC related to mental health organizations.

- Leadership: The suggested form of leadership is decentralized decision-making with shared leadership structure among the main organizations in the IOC (CMHA, Laing House, MH Foundation, Peer Support Groups). Smaller (students) group can join in decisions related to shared programs that are directed to students. They do not take part in the main strategic decisions of the IOC.

- Relationship Building: Some of the steps for building relations between the IOC, other organizations include liaising with public health and social organizations in Nova Scotia; creating partnerships with other non-profit organizations; partnering with government organizations such as education and labour organizations. Building partnership with communities and individuals involve building positive community relationships to support the work of the organization (Chiou 2011). Activities that contribute to building community relations include connecting with communities to understand the needs of different communities and individuals the organizations serve. Cooperating with educational organizations in the stages of the collaboration provides a source of knowledge and expertise to the IOC. Literature mentions that building partnerships with educational and research enterprises provide mental health organizations with sources of knowledge (frank and Smith, 2000) that support their improvement in different aspects.

- Risk assessment: To be able to adapt to different conditions, The IOC strategy should include tools for identifying and assessing potential risks, and plans on how to mitigate those risks. Risk identification tools should also consists of backup plans when dealing with risks if they arise Example of risks include not viable and conflicting expectations (Sicotte et al., 2006), resistance to change, conflicts, lack of support, shortage of staff members to implement the needed projects, changes in the outer environment, and financial difficulties.

b- Roles and responsibilities

Table 2 shows the expertise and the suggested roles and responsibilities[15] for the IOC for MH in NS. We developed this table based on the review of the expertise and areas of work of those organizations. The table also includes stakeholders, offices and roles that can be added in later stages of the IOC.

Table 2. Expertise and roles of the IOC for MH services

Organization	*Expertise*	*Suggested roles in IOC*
CMHA	- Leadership, support for MH, mental illness prevention, population-based awareness, education and training, resilience.	- A source of information related to the context of MH services in NS including issues and ways to deal with them. - Experience in dealing with MH in conditions of disruptions. - Share in all parts of the decision-making process.

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[15] https://www.coursehero.com/file/65959422/BSBPMG520-Governance-Plan-Template/

Organization	Expertise	Suggested roles in IOC
MH Foundation of NS	- Efforts to increase financial support to community initiatives throughout NS. - Works on eliminating stigma around mental illness and addiction[16].	- Suggest plans to increase the financial capabilities of the IOC. - Share in all parts of the decision-making process.
Laing House	- Empowering young people living with mental illness by providing well-rounded support in young people's wellness plans[17].	- Share information related to the status of the young population (areas of need for mental health, locations that need more focus). - Experience in direct contact with the population in need. - Share in all parts of the decision-making process.
Peer Support Program	- Provide help to people with mental health problems and support communities.	- Share the daily experience of mental health of different communities. - Share knowledge on approaches to address different MH needs in the community. - Share in all parts of the decision-making process.
Student groups (assumed group)	- Connecting with students facing mental health issues. - Communicate with teachers, administration, and faculty to help with MH issues among students.	- Provide hands-on experience on MH problems among student populations. -Take part in joint projects directed to students and youth and suggest best approaches.
Other offices/administrations that might join the IOC for mental health services (temporary or permanent)		

[16] https://www.mentalhealthns.ca/

[17] https://www.lainghouse.org/

Organization	Expertise	Suggested roles in IOC
Suggested members: mental health coordinator/case worker/coordination organizations (Brooks et al., 2020). Roles can be assigned with the agreement of all organizations or chooses from members of the organizations.	- Can act as a central point in directing patients or populations to mental health services after collecting the needed information. - Experience with using and analyzing data, communication and good knowledge of and relation with mental health, health and other community organizations.	- Uses the information or data and communicates other mental health organizations inside or outside the IOC to direct patients to the available services.
Other suggested organizations, stakeholders that communicate or join with IOC for mental health services		
Direct users /Stakeholders	- Mental health patients in Nova Scotia. - General public. - Labor unions and organizations (schools, not-for-profits, universities).	- Provide feedback on the needs and actions implemented by the IOC. - Their opinions and feedback influence decisions taken by the IOC. - Can coordinate or collaborate with the IOC in joint events, or programs.
Indirect users/stakeholders (Campbell et al., 2004).	- Non-for-profit organizations (community, religious organizations, groups promoting wellbeing, art and music) - Immigration organizations.	- Provide information about the needs for mental health services in their communities. - Join in capacity creation and improvement such as training members in mental health support or providing spaces for mental health support. - Their opinion and feedback influence decisions taken by the IOC. -Can coordinate in shared events and programs.
Government stakeholders	Health agencies, decision-makers in NS.	- Potential future contributors to the collaboration or collaborators. - Support in funding, expertise, technology. and training.

Organization	Expertise	Suggested roles in IOC
Other potential partners	Private counselors, natural therapy practitioners.	Share experience and vision, cooperate in main direction, have certain financial agreement and cooperation.
Competitors: Private counselors or therapists might be competitors in some areas. It would be good to establish partnership with them to build sharing of benefits and expertise.		

c- Financial planning and assessment

Initial financial planning is done at the stage of building the initial IOC strategy. As the IOC may evolve and the environmental and contextual factors may change, the financial plans should be revisited and updated. Financial plans should start with the assessment of IOC financial capacities. This includes how the shared resources can be harnessed to achieve the goals of the organizations. A useful tool is creating a financial map of all available resources (World Health Organization, 2019). Throughout their operation, IOC should conduct research on methods and tools to sustain and improve their financial capabilities to be able to meet emergent financial needs, and the needs of the people they serve. It is mentioned that researching ways to achieve financial growth (Dean 2910) provide organization in the IOC with tools for future expansion. Again, the alignment of different parts in the IOC strategies is important. The organizational and financial strategies should be aligned with the IOC goals, objectives, and capabilities. Organizations should jointly agree on methods and strategies to mange resources and record financial activities (Olson et al., 2011). Financial plans and strategies should also include assessment of potential financial risks and how they can be mitigated (World Health Organization, 2019). Appropriate IT tools can be used to aid in financial tracing and management.

In health and mental health, IT and network approaches have proven to facilitate and support healthcare communication among organizations. The adaptation of IT and internet has become essential to the work of health and mental health organizations. We understand that MH health organizations use IT applications in different degrees.   The use of IT has many advantages as well as risks and challenges (Prasad et al., 2012). An important issue in information and data approaches is the confidentiality and privacy of users (Jutla and Bodorik, 2005). Protecting peoples' information is essential in any application of IT related to community healhtcare and mental healhtcare.   We discuss two approaches to data and information sharing and they are the Transaction in Real Time (TRT) approach and the Hub approach. Next, we review benefits, advantaged and challenges of each including confidentially and cost. Then we propose a criterion for IOC organizations to choose between approaches in data and information sharing.

The Transaction in Real Time Approach (TRT)

Explanation of TRT

The TRT offers unique features to aid in the exchange of information among health/ mental health organizations in micro and macro levels (Louws, 2015). TRT has high adaptability; it can be adapted and scaled to operate in various circumstances relating to the mental health organizations. It can be adapted to the joint IOC requirements as well as individual requirements of the mental health organizations. In mental health services, practitioners need to handle and share personal and sensitive information to make decisions (Bellamy et al., 2008). As mentioned, the security of patients' information should be an essential feature in health and mental health information systems. One of the security features in TRT is its dataset that dissolves after certain time erasing all the information (Louws, 2015). A vital part in the operation of mental health organizations in IOC is sharing the information of patients (Karlson et al., 2020). The TRT provides a tool to do

this in a more efficient way. Traditionally, mental health organizations communicate via phone calls, faxes and case meetings that increased wait times and caused process backlogs. By using TRT, a coordinator or coordinating organization can manage information sharing among organizations. According to the information acquired from the organization, the coordinator or coordinating organization can formulate the needed plan to direct patients to the available mental healthcare resources according to their needs. The addition of a coordinator enables better allocation to mental health facilities and supports assigning individualized services to patients. Discussed in the previous essay is the importance to address the different needs and characteristics of patients when designing mental health services.

Benefits of TRT

- Protects data privacy for individuals while delivering key information among organizations.

- Is not very complicated: does not require the integration of systems, interoperability, joined-up record keeping, database linkage, or the construction of a large database.

- Does not incur huge costs for maintenance.

- The cost of initiating the databases is not large due to the reasonable size of those data bases (Louws, 2015).

Agreements/specifications when using TRT

When adopting TRT technology, organizations should agree on the following aspects:

- The expiration date of the limited-life dataset.

- The portion of information and data that can be shared on the electronic record and the conditions that permit sharing this information.

- Agreements on post-transaction events such as an audit trail which could remain after the virtual instant.

- Agreements on funding and finances including initial capital and funding of operation and maintenance.

Limitations of TRT

- At times in mental healthcare, there are special situations that need to be identified on a case-by-case basis and it is not appropriate to share information about those cases electronically (Louws, 2015).

- Difficulty in mutual agreements on main operation terms: various levels of management may not agree (Colvin et al., 2020); organizations may not be familiar with maintaining a transparent communication process.

In some situations where cases need to be assessed individually, we suggest using mixed methods of TRT and individual assessment. The more critical cases can be handled individually, and the critical information related to those cases do not have to be shared via TRT.

The Hub Approach

Explanation of the Hub

The Hub is a central pool that identifies individuals and/or families with high risk factors related to mental health that cannot be addressed by a single agency alone. It gathers important information about those individuals and families and connects them with the right services when needed (Saskatchewan, 2017). This way, the Hub enables mental health and/or social organizations to respond to the needs of individuals and families in a timely manner. The Hub takes a structured and institutionalized approach to data collection and data sharing that includes organized recording

of data in a central database. To preserve security, the Hub only allows relevant service providers and stakeholders to have access to the clients' information.

Benefits of the Hub

- Continuously reviews and records data and available programs and interventions related to mental health. This data can be used to suggest policy direction and improvements.

- Provides interactive response to the needs of vulnerable populations in a comprehensive manner. The Hub links populations and individuals with a widespread set of mental health and related services. The assessment of vulnerable population in the Hub is done by conducting a thorough analysis of risk and other factors related to the populations and their needs (Saskatchewan, 2017). Research mentions that understanding the characteristics of vulnerable populations helps to deliver mental health services that address the needs of those populations (Moret 2014).

- The Hub supports cooperation among organizations directed and linked to mental health. It does that by providing a tool for professionals in different mental health organizations to work collaboratively to meet the needs of patients and populations.

Requirements and agreements of the Hub

- Data analytics are critical for ongoing measurement and evolution.

- Building and sustaining a structured database is essential (Saskatchewan, 2017).

- Agreement between the organizations on the nature and the scope of the information to be shared is vital.

- Meetings and discussions should be held to bring together representatives from MH and human service agencies operating in local and surrounding communities.

- To provide the needed supervision and management of privacy and legal issues when applying the Hub, specialized organization bodies and/or groups should be constructed such as cross-government information sharing working groups.

- The need to construct groups or bodies to manage financial matters and funding.

- There should be continuous management and coordination of the chosen interventions and assessment of the risks when applying of the Hub approach in the IOC.

Limitations of the Hub

- Needs a very structured database[18] which can be complicated and costly.

- Has a complicated process.

- Has a high setting cost.

- Needs continuous maintenance which incurs high costs.

- Needs high and specialized technical expertise.

- Needs structured and strong coordination between the MH and social organizations that may not be feasible in early stages of IOC (Saskatchewan, 2017).

Criteria for choosing data and information sharing approaches

When choosing a certain data sharing IT application in IOC, organizations should consider certain factors related to the strategy and the operations of the organizations. Those main factors are listed below:

- Alignment with the goals of the IOC (Johansson et al., 2021; Jutla etl al., 2021). Before adopting an IT approach, the IOC planners should ask the following questions: is the chosen technology able to solve or address the problems/goals stated in the IOC for MH?, can the technology be adapted to the requirements of the IOC?

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[18] https://www.hitechwhizz.com/2020/09/5-advantages-and-disadvantages-drawbacks-benefits-of-hub.html

- Alignment with organizational structure (Yu et al., 2010): In choosing a certain IT approach, the compatibility of the IT with the IOC structure including leadership type, decision-making hierarchy, roles of members should be assessed. To prevent misalignments and operation issues, the IT approach should be compatible with the IOC goals, abilities, and structure (Jonathan, 2018).

- Feasibility: The requirements of the chosen technology should be compatible with the IOC technical capabilities (Karlsson et al., 2017). Before choosing an IT approach organizations should make sure that they have the required technical capacities to operate and deal with the chosen IT application. In some cases, organizations need to consider collaborating with more powerful partners, or hiring IT specialist to meet the IT requirements.

- Usability of the technology: It is important for any IT application to be user friendly to the people working on these applications (Carayon et al., 2019). It is reported that poor usability of health IT applications produces negative impacts on the outputs of these technologies (Staggers et al., 2018) and discourages people from using them. Organizations should also check the availability of training associated with the chosen IT approach.

- Security: It is essential to ensure the security of IT approaches and applications in relation to the organization strategy and the nature of the exchanged information. In addition, unexpected security threats should be investigated (Waithira et al., 2019). IOC organizations should acquire the needed tools to preserve data security and protect information. Initial policies and procedures of data sharing should be discussed and assigned jointly by the organizations (Kuperman 2011).

- Flexibility: Organizations have to ask the following questions when choosing IT approaches: how can the technology be developed to work in different contexts and

different conditions? (Nurdiani, 2012); is the technology flexible enough to perform a wider range of functions in later stages of the IOC ?. As discussed earlier, the IOC is a dynamic evolving process and the IT application should provide reasonable flexibility to accommodate changes and expansions.

- Costs: When implementing IT approaches, the cost effectiveness of the technology should be evaluated (Shekelle et al., 2006). The benefits of the technology should exceed the cost of buying, setting, securing data, and maintain the technology. Cost assessment consist of calculating the cost of adopting and initiating the technology and the cost of implementation the technology.   Other costs are the costs of building the data base, buying special equipment like advanced computers, maintenance cost, and security cost.

- Testability and reliability: The testability and the reliability of the technology should be checked (Nurdiani, 2012) before choosing that technology.

- Other aspects that should be checked before choosing IT approaches are the resilience of technology and how easily it can be repaired (Dittes et al., 2019). Also, the licensing requirements of the technology and how does those requirements align with the IOC strategy and rules.

Step 5- Delivery of functions in the inter-organization collaboration

Working closely with communities in NS enable the MH organizations to understand the needs of the communities and take the right decisions. It is indicated that communities are both a source of information for IOC and important partners with the MH organizations (Crisp et al., 2000). The inclusion of communities and people in the IOC transforms individuals from passive recipients of mental health services to active participants in a process of capacity building (Finn and Checkoway,

1998). Moreover, partnerships with communities, develop more capacities for the organizations and extend the scope of the collaboration (Annie E. Casey Foundation, 2005). Examples of community partnership approaches are joint program collaboration (World Health Organization, 2005) and community support programs.

Step 6- Assessment of the inter-organization collaboration process

 To ensure that the IOC is achieving the assigned goals and delivering the needed services to individuals and populations, organizations should access the IOC on regular basis. According to Donabedian, (1972, 2005), the three main dimensions of quality assessment are structure, process, and outcomes. Those are evaluated from three domains: management, the professionals, and the users of services (Cropper et al., 2009). Combining the mentioned dimensions result in the IOC assessment matrix. With reference to Ahgren (2007) and Woodland and Hutton (2012) and the conducted review, we adapt the quality assessment model to IOC collaboration of mental health care organizations (see Table 3).

Table 3. Assessment of the IOC for MH services

Assessment perspective	Structure	Process	Outcome
Management	Assessing the managerial abilities of the IOC MH organizations (A). Asses whether the IOC is able to manage all aspects of the operation in a comprehensive way.	The assessment of work routines examines if the IOC organizations were able to achieve their stated goals. This assesses the effectiveness or the strength of the coordination in the IOC (B).	This part assesses if the management of the organization was able to achieve the desired outcomes. It determines if the IOC had resulted in improvements in the

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			management of the organizations (C)
Professionals	Assessing the competencies and experience of the professionals and staff (Škrinjarić, 2022) in IOC for MH (D). Determine whether the available competencies were able to achieve the IOC goals.	Evaluates the collaborative efforts between MH professionals to develop skills and build knowledge (E)	Evaluating the development of skills, expertise, and knowledge (Woodland and Hutton, 2012) among IOC that address the stated problems or achieve the objectives (F). Did the IOC result in new knowledge and skills?
Service users (patients)	Assesses how IOC empowers patients and replies to their needs. Did the IOC provide patients and populations with the right knowledge and tools to understand their needs. Patients should be empowered to express their needs (G)	Test the degree of patient involvement in decision-making in MH services (van der Weijden et al., 2012). Evaluate the effectiveness of communication between patients and MH organizations in the IOC (H).	The success of the IOC in improving the quality of life and well-being of people is assessed (Karlson et al., 2020). Tests if the organizations were able to achieve the stated goals by the IOC (I). Assessment can include the opinions of people that receive the services or monitoring the progress (outcomes) of the IOC.

According to Ahgren (2007), these elements relate to each other in a sequential manner within the same domain: (A) → (B) →(C). At the same time their outcomes are sources of inputs to other domains. The wellbeing of the people (I) represents the most important outcome of all the stated factors in the IOC. The main objective of the IOC for MH is the outcome stated in (I). This meets with our objective of essays 2 and 1 in achieving the most important aim in mental health service

and health services which is the wellbeing of patients and populations. The assessment framework also links to the view in essay 2 on the importance of incorporating the opinions of patients in designing mental health services. The results of the assessment of the IOC will provide feedback that will determine what actions must be taken to strengthen or extend the collaboration or solve problems in the collaboration.

4.6. Conclusion

4.6.1 Discussion

In this study, we developed a process for inter-organizational collaboration between mental health organizations in NS to improve capacity and resilience. We proposed a stepped framework for inter-organization collaboration for Nova Scotia's mental health organizations and developed the IT and organizational strategies for mental health organization in IOC. We discussed factors of success of inter-organization collaboration as well as challenges of IOC. We also discussed main directions to overcome those challenges. We stated that IOC is an evolving process, and that it is important to assess the outcomes of the collaboration in different stages. The outcomes of the assessment can be used as feedback to improve the collaboration. Based on the literature review, we developed a versatile model for the assessment of IOC focusing on mental healthcare that can be applied to similar collaboration structures. We emphasised that the process of building collaboration among organizations should carefully consider the aims, the context, and the characteristics of the organizations. To achieve the best outcomes, mental health organizations should make sure that the problems they target meet the needs of the communities they serve. This further emphasises the statements in the previous essays on the importance of designing mental health services that replies to the needs of the people.

The agreement among mental health organizations in the IOC on goals and objectives is essential to the success of the collaboration. Organizations should agree on definition/s of the common problem/s and goals including primary and secondary goals. The joint objectives of the IOC can be an issue that the organizations need to solve or can be derived from a need to improve the outcomes or operations of the organizations. In this study the mental health organizations needed to address the issue of capacity shortage. They also had the objective of improving their resilience. As indicated, IOC is a developing dynamic process. With time, organizations in the IOC gain more capacities and experiences to deal with the public and solve the issues they face. By this organizations develop new sources of knowledge and increase capacities. The collaborative mental health organization in Nova Scotia can use the knowledge gained from interacting with the public to enhance their capacities and design services that understand the needs of the public related to contextual and other factors.

In this study, we presented an initial structure for IOC collaboration between mental health organizations in NS. We think that to transfer from a state of fragmentation to the needed state of collaboration, the collaboration should be implemented in feasible and gradual steps. We agree with Aunger et al (2021) in that trust among organizations is an essential factor in building successful IOC. Sometimes, there is a need to build this trust grdaualy through networking or simpler form of collaboration structures. As trust among organizations is built, more collaborative strutcters can be composed. We argue that the best initial stage for mental health organizations in NS is to conduct a collboration between organizations that have previous relations and worked with each other.

Considerations of factors such as the readiness of the organizations, the financial constrains, the capabilities of the organizations should be incorporated in designing and initiating IOC. In later stages, the scope of the IOC can be extended to include larger government and non-government

organizations as the organizations develop more capabilities and strengthen trust. To gain more power, increase financial capabilities and extend community reach out we suggest including more powerful organizations in later phases of the IOC. These could be large public hospitals or government health and social organizations. The structure can move to a more centralized structure in some aspects of the collaboration. Other organizations like municipalities or third-party organizations can join the IOC in areas related to data and information, especially if there is a need to build a central database for patients' data. When more organizations join the collaboration, a network collaboration structure may evolve which requires more complicated governance methods. Approaches like supply chain may be established to coordinate the processes of the organizations. This work replies to the realistic need of mental health organizations in Nova Scotia to improve capacity and resilience. This study provides guidelines to mental health organizations and policy makers in understanding the factors of success and challenges in building collaboration among MH organizations. It presents structured directions for initiating and developing initial IOC thorough the presented process and strategy. As well as a layout of assessment steps of the collaboration in link to the context of mental health. The framework and strategies can be adapted to other healthcare and community contexts considering differences in the environmental and structural characteristics.

4.6.2 Extensions and future research directions.

This work can be extended to address more complicated collaborative networks that include educational, social, and other organizations. It is mentioned that the collaboration among mental health and community organizations is essential in providing comprehensive services to individuals in needs of those services.   This it is very important for mental health organizations to collaborate

with social, justice, housing, heath, education, and other organizations that work to provide inclusive solutions to mental health problems.

As stated, more complicated and extended collaboration may require different and several imbedded collaborative structures. It would be interesting to investigate these structures and identify the best ones. Collaboration maps and networks can be applied to large stage collaboration that may extend to other provinces. A potential for future research could be to discuss the implementation of network collaborative themes among mental health organizations and the IT requirements of those structures. Supply chain applications can support IOC specially more complex collaboration forms.

Collaboration can also include larger organizations of public sector health or mental health organizations. Research mentions that collaboration between private and public sectors can be effective in building resilience (Geographical Sciences Committee Board, 2011). Larger organizations can provide resources to smaller ones. In addition to MH collaboration within the province, future work can investigate the inter-province collaboration between mental health organizations where different challenges may arise. A first step will be MH collaboration among the Atlantic provinces. Within that, the impact of different context and themes of organizations on the IOC can also be analysed. Such as differences between mental health organizations that serve populations in urban areas and those that serve rural communities. Future studies can include how to incorporate those differences in the IOC. A potential future research can be on how the collaborative organizations can deliver mental health services of the needed levels of individualization and standardizations to the communities they serve.

Different challenges may arise in developing collaboration between provinces which require different collaboration design. The application of supply chain approaches in mental health IOC is interesting. This could include the roles of different organizations, the people and the communities

where the services are delivered. An extension to this research is to identify facilitators and challenges of inter-organizational collaboration in Nova Scotia. This is done by collecting primary data from a number of mental health organizations on their perspectives of inter-organization collaboration, the challenges they face, and how to overcome those challenges. This can be done via focus groups, surveys, or both. In addition, in the next stage of this work we plan to document in details each individual partner organization's operational capacity, shared responsibilities, and desired outcomes. This may include cost, demand, scheduling, process management, location, and various resources available.

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Appendix

A list of the mental health organizations in Nova Scotia.

1. Nova Scotia Mental Health and Addictions Crisis Line and helplines

Helplines 211 Nova Scotia: This network includes everything from local community groups and non-profits to government departments across Nova Scotia. Services are available in over 150 languages. Helplines were created in partnership with the Eastern Shore Family Resource Centre. People can access a variety of supports and services specific to their needs, including information, navigation, referrals and brief intervention counseling.

Men's helpline: A free, confidential service for adult men, and individuals who identify as men, who have concerns about their well-being, safety, and/or the safety of others. Eligibility: Men, and individuals who identify as men, can access a variety of supports and services specific to their needs, including information, navigation, referrals, and brief intervention counselling.

Women's Helpline: A free, confidential service for adult women, and individuals who identify as women, who have concerns about their well-being, safety, and/or the safety of others. Eligibility: Women, and individuals who identify as women, can access a variety of supports and services specific to their needs, including information, navigation, referrals, and brief intervention counselling.

Mental Health Crisis Lines: Provides any Nova Scotian with a mental health or addiction question, concern, or illness immediate access to a trained clinician 24 hours a day (Province of Nova Scotia, 2019).

Canada Suicide Prevention Service and Crisis Services Canada: This service is available across Canada via toll-free phone (English or French) or text in English. This means anyone in Canada who is thinking about or has been affected by suicide can reach out via a variety of media and feel supported 24 hours a day, 7 days a week.

Red Cross Friendly Calls: Available to anyone who is feeling isolated or lonely due to COVID-19. To receive friendly calls, Red Cross asks that people register. Can often accommodate calls in English or French, as well as other languages. If desired, Red Cross can provide contacts for other support services in your community.

Trans Lifeline: A grassroots hotline and microgrants (fund), non-profit organization offering direct emotional and financial support to trans people in crisis – for the trans community, by the trans community.

Eating Disorders Nova Scotia: Support through nutrition counselling, a mentor program, peer support, and friends and families peer support.

First Nations and Inuit Hope for Wellness Helpline: Established as a specific resource for First Nations and Inuit to provide immediate, culturally competent telephone counselling, 24 hours a day, 7 days a week. Available in English, French, and upon request in Cree, Ojibway, and Inuktitut. Online chat services are currently available in English and French with expansion to Indigenous languages being explored as this new service launches.

Eskasoni Crisis and Referral Center: Facebook messenger: 24-hr crisis and support line available to members of Mi'kmaq communities. Provides emotional, social, and educational support. Assists individuals with referrals to counselling and helps navigate to agencies and services. Services are provided in Mik'maw and English.

2. Online Communities and Services

Together All: A safe and anonymous online community where people can share what's troubling them. The service is free to all youth and young adults aged 16–29 in Nova Scotia and allows people to get support, take control, and feel better, all in a way that is most comfortable to the individual. Peer support is moderated by trained counselors.

Kids Help Phone: Canada's only 24/7 national support service. Offers professional counselling, information and referrals, and volunteer-led, text-based support to young people in English and French. The service is completely confidential.

3. Services Directed to Youth

Teen Mental Health.org: Resource presented by Dr. Stan Kutcher, SunLife Financial Chair in Adolescent Mental Health, aimed at improving the mental health of youth by the effective translation and transfer of scientific knowledge.[19]

Good 2 Talk: Provides confidential support services for post-secondary students in Ontario and Nova Scotia.

4. Therapies and Counseling

Affordable Therapy Network: An initiative to increase access to affordable therapy and counselling services across Canada.

5. Mental Health and Addiction

IWK Mental Health and Addictions Intake Service: If you need help with a mental health and addictions concern our team is here to help. Provides both real people and voice services.

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[19] teenmentalhealth.org

Mental Health and Addictions Tools: A comprehensive resource list of free online resources available through community partners such as Nova Scotia Health Authority (NSHA) and others.

6. Services for Special Populations

IBPOC (Indigenous, Black & People of Color) Service Provider Database: Resource to share information and highlight IBPOC mental health workers and services local to Kjipuktuk/Halifax. This database was created to highlight a range of local services, programs, and IBPOC mental health workers for IBPOC residents of Kjipuktuk/Halifax. It is updated regularly. To learn more, visit www.khyber.ca

National Eating Disorder Information Centre (NEDIC): NEDIC provides information, resources, referrals, and support to Canadians affected by eating disorders through its toll-free helpline and instant chat. Outreach and education programming focuses on awareness and prevention of eating disorders and is available online across Canada and in-person in the Greater Toronto Area. NEDIC has a non-dieting, client-centered, feminist philosophy. Promotes healthy lifestyles, including appropriate, enjoyable exercise and eating.

National Centre for Truth and Reconciliation Residential School Survivor Support: Provides support and crisis lines for residential school survivors who need emotional support. Emotional, cultural, and professional support services are also available to Survivors and their families through the Indian Residential Schools Resolution Health Support Program. Services can be accessed on an individual, family, or group basis.

Pride Health: Works to improve access to health services in Nova Scotia which are safe, coordinated, comprehensive, and culturally appropriate for people who are two-spirit, lesbian, gay, bisexual, transgender, queer, intersex, asexual (members of the 2SLGBTQIA+ community). Offers health resources, navigation, and referrals for addictions, mental health, and other health services.

Post-Partum Support International Helpline: A toll-free telephone number anyone can call to get basic information, support, and resources. It is based in the USA but helpline and support groups are available to Canadians. Messages are returned every day of the week. If you are unavailable when they call, you can set up an alternative time. The volunteer will give you information, encouragement, and names of resources near you. PSI also hosts weekly chats with experts, online postpartum peer support groups, and online meetings on various topics. Specific groups include support for adoptive parents, queer parents, groups for dads, support groups for pregnancy loss and more.

Eating Disorders NS: A not for profit organization working to create supports for those impacted by eating disorders. Our Peer Support Groups provided a welcoming, non-judgemental space for those working on recovery (https://eatingdisordersns.ca/about-us).

SOAR: Survivors of Abuse Recovering: A community-based peer support service for adult survivors of childhood sexual abuse in West Hants, Kings, and Annapolis counties (Nova Scotia, Canada). They offer peer counselling, support groups, and community awareness training.

Thoughtful Changes: A non-profit group of counselors dedicated to providing affordable care to Nova Scotians. Intake appointments are $50, ongoing services are provided on a sliding scale at $50–$80/session. Also offers a pay-it-forward program where people who can afford to pay higher than the regular fee can contribute to reducing costs for people who struggle to pay.

The Unison Benevolent Fund: Offers a toll-free number to connect Canadian music professionals with resources and support for personal and practical issues. This service is free, anonymous, confidential, and available 24 hours a day, 7 days a week. Before you make the call, please register with Unison on their website. Service is available in English and French.

Project H.O.P.E: Works with Nova Scotians who are homeless or at risk of homelessness to locate and secure safe, sustainable, affordable housing. Project H.O.P.E serves people living in Kings, Annapolis, and Digby counties with housing support and trustee services. Also serves Truro and area with trustee services. Referrals can be self or agency.

7. General Services for Mental Health

THRIVE: An innovative, safe, and welcoming learning space that provides free courses designed to support mental health, boost resilience, and promote connection. THRIVE courses are developed by subject experts and mental health professionals, working together with people who have their own experience in personal recovery. No previous experience is required and with a variety of courses to choose from, there is one for everyone. (Courses are updated quarterly.)

Laing House: A non-profit organization dedicated to empowering young people living with mental illness by providing well-rounded support in young people's wellness plans, which leads to better outcomes. Offers quality, non-clinical, people-centered mental health support for youth aged 16–29.[20]

Strongest Families: An innovative, cost-effective, distance education program that uses trained coaches to work with children experiencing mild to moderate behavior and anxiety problems and their families. As part of the strategy, the Nova Scotia government committed to expanding this service offering to all areas of the province (previously only offered at the IWK and in Cape Breton), so that families could benefit from the service no matter where they live (Province of Nova Scotia, 2019).

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[20] https://www.lainghouse.org/

Peer Support Program: An innovative program that formalized a grassroots concept of persons with a mental illness helping their peers. Trained and certified peer support specialists have helped their peers with in-patient to community transitions across the province (Province of Nova Scotia, 2019).

Canadian Mental Health Association of Nova Scotia: Founded in 1918, CMHA is a national charity that helps maintain and improve mental health for all Canadians. As the nationwide leader and champion for mental health, CMHA promotes the mental health of all and supports the resilience and recovery of people experiencing mental illness. In Nova Scotia, the CMHA provincial division provides leadership support in the areas of mental health promotion—injury disease prevention, population-based awareness, education, and training. CMHA NS Division provides a wide range of innovative community, workplace, and school-based services and supports

Mental Health Foundation of Nova Scotia: A registered charity that works to increase financial support for community initiatives throughout Nova Scotia while providing hope and eradicating the stigma around mental illness and addiction.[21]

Wellness Together Canada: Created in response to an unprecedented rise in mental health and substance use concerns due to the COVID-19 pandemic, with funding from the Government of Canada.

Strongest Families Institute: Programs include learning anxiety-coping skills or behavior management tools, including weekly telephone coaching sessions. Referrals required via family doctor or provincial intake line.

Healthy Mind Cooperative: A charitable, non-profit organization. It is a peer-led, member-driven organization, committed to improving the lives of people with mental illness (including

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[21] https://www.mentalhealthns.ca/foundation-profile

addiction). Focus include advocating for better access to mental health services; public education about mental illness; reducing stigma towards mental illness; peer support and advocacy for consumers and their families; more participation in the decision-making around mental health services; wellness workshops; and connecting to existing community services (https://www.healthyminds.ca/about).

8. Regional Mental Health Support Organizations

Annapolis Valley: Mental Health & Addiction Services, CMHA Annapolis County Branch, CMHA Kings County Branch.

Cape Breton: CMHA Cape Breton Branch, Emergency Crisis Services, Adult Outpatient Services, Inverness Mental Health Clinic, Seniors Mental Health Program, Adult Services, Child and Adolescent Services.

Colchester, East Hants: Mental Health & Addiction Services, CMHA Colchester/East Hants Branch.

Cumberland: Mental Health & Addictions Services.

Guysborough, Antigonish, Strait: Mental Health & Addictions Services.

Halifax Regional Municipality: Healthy Minds Navigator: A healthcare cooperative providing a variety of peer-based services to people living with mental illness and their families, including assistance with navigating the mental health system.[22]

Community Mental Health Clinics are staffed by a team of professionals who provide a range of services to help people manage their mental illness and improve their mental health. Services are available at no cost to adults:

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[22] www.healthyminds.ca

- Bayers Road Community Mental Health

- Bedford/Sackville Community Mental Health

- Cole Harbour/Eastern HRM Community Mental Health

- Dartmouth Community Mental Health.

- West Hants Community Mental Health & Addiction Services

9. Mental Health Services

Pictou County: Mental Health & Addictions Services, Pictou County Health Authority, Child, Adolescent Mental Health Services, CMHA Pictou Branch.

South West Nova: Mental Health & Addictions Services, CMHA Yarmouth, Digby, Shelburne Branch.

South Shore: Mental Health & Addictions Services, CMHA Lunenburg County Chapter. There are also mental health services in schools and universities across the province.

5. General Conclusion

This study addresses the enhancement of mental health services in Canada. It investigates the major obstacles to the delivery of proper mental healthcare in Canada and they are access, capacity shortages, quality issues, and the fragmentation of the mental healthcare organizations. By proper mental healthcare, we refer to services that are easily accessible by patients, meet the needs of patients and provide the right quality of care. We view mental health services as a system (Peters 2014; Clarkson et al., 2018) of connected parts. It is stated that deficiencies in one part of a system impact other parts and the performance of the whole system. Golden and Marin (2004) stated that following a systems' approach supports the reform of the Canadian healthcare and mental healthcare services. This allowed us to analyse the multidirectional impacts of malfunctions in the mental healthcare services. To do that we developed comprehensive analytical models to identify and validate the impacts of gaps in the mental health services in Canada on the performance of the mental health system. Based on our analysis and reviews, we derived solution paths to solve the stated issues in the mental health services. We validated those solutions and derived optimal strategies for health and mental health services reform. We also proposed and developed practical strategies to support collaboration among mental health organizations.

The first essay in the dissertation investigates how access issues in the mental health services impact the operations at the emergency department for mental healthcare, and increases the cost of mental health services. By developing a newsvendor model, we numerically illustrated the link between access to mental health services, and the movement of patients to emergency department for mental healthcare. We derived optimal solutions on capacities to manage the high use of emergency departments in Canada for mental healthcare. We also analysed how factors related to the cost and location of the mental health services impact the allocations of optimal capacities in

the mental health system. The second essay complements the first in tackling the issue of quality in the mental health services. In our models and analysis, we incorporated system and patient factors in the design of mental health services that deliver the needed quality to the patients. We discussed service design within the lenses of effectiveness and efficiency. It is stated that health and mental health services should provide the right balance of effectiveness and efficiency. We discussed standardization and individualization as main factors of quality relating to effectiveness and efficiency. Using analytical approaches, we developed guidelines to mental health service design that incorporate the right balance of standardization and individualization. The third essay is a continuation of the first two essays in that it replies to the need of improving the capacity and resilience in mental health organizations in Nova scotia. The study addresses the fragmentation among mental health organizations and presents a strategy for inter-organizational collaboration to build capacity and resilience. We developed a framework consisting of a detailed practical process for collaboration among mental health organizations in Noa Scotia.

Through its diverse analytical and conceptual approaches, the thesis develops important tools to improve the mental health services in Canada. In our comprehensive approach we incorporated important dynamics between different factors in the mental health system such as cost factors, patient factors, behavioral factors, health factors and contextual factors. Up to our knowledge, most research in health and mental healthcare miss to include this range of interactive factors in relation to mental health services (Simonse et al., 2019; Khenti et al., 2016). Importantly, we analysed the dynamics of those factors within the mental health system. An important contribution of our work is that it combines solutions to issues in mental health services that incorporate both operational and strategic levels of mental healthcare design and delivery. Most research in healthcare address those areas in isolations. Another important contribution is the integration between management

science applications and healthcare/mental health scope. To be able to improve healthcare and mental healthcare services, there is a high need to link analytical research with healthcare services research. The outcomes of this research can be used as guide to improve health and mental health services. Our findings deliver important policy and strategic directions to the improvement of the mental health services in Canada. The proposed approaches can be applied to other health and mental health services after accounting for contextual differences. The logical procedures in this study can be applied to develop programable approaches for solutions in the mental health system. Such scopes can include the application of machine learning approaches to mental health service design, creating interactive simulation models to identify gaps in the health and mental health services, expanding the models to more than one time period, and applying feedback methods to investigate the aftereffects of mental healthcare. Moreover, deliverables can be extended to develop a plan for collaboration and assessment for an expanded range of mental health organizations in the national scope with special focus in resilience and capacity improvement.

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