

## Benchmarking rehabilitation efficiency across Canadian provinces: A DEA-based analysis of throughput and budget allocation

Rouzbeh Ghousi<sup>a\*</sup>

<sup>a</sup>Department of Industrial Engineering, School of Engineering, Iran University of Science and Technology, Tehran, Iran

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ABSTRACT

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Therapeutic recovery services are considered essential towards restoration of functional independence and the quality of life across Canada. Greater needs and constraining opportunities have begun emphasizing assessing the relative efficiency of all rehabilitation centers to help with evidence-based policy and funding decisions. Thus, this article subject's throughput, functional outcome, and budget allocations for ten Canadian provinces to analysis using DEA to provide a comparative look at service delivery and resource utilization. The results disclose that Prince Edward Island demonstrates the highest efficiency in utilizing rehabilitation budgets, followed closely by Nova Scotia, Manitoba, and Alberta. These provinces provide strong throughput and functional gains in spite of modest funding levels. In contrast, Quebec shows lower relative efficiency, suggesting potential gaps in resource deployment or care coordination. These results underscore the relevant importance of strategic investment and outcome-driven planning in rehabilitation policy, giving actionable insights for provincial health authorities and national benchmarking efforts.

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## 1. Introduction

Rehabilitation services are the post-acute healthcare-centered services enabling clients to regain their functional independence while re-entering society. With increased demand upon aging population demands, chronic illness demands, and post-surgical recovery demands placing further strain upon these, the demand for rational allocation of resources grows (Allin et al., 2016). The provision of rehabilitation in Canada differs from one province to another in terms of funding, throughput, and patient outcomes, yet little systematic benchmarking occurs (Stinear et al., 2017).

This research attempts to fill such gap and applies DEA to assess the relative efficiency of rehabilitation services in the ten Canadian provinces. Taking Estimated Annual Budget as input and Avg Admissions per Center and Functional Gain (FIM score) as outputs, the study studies whether each province, converts financial resources into volumes of service and functional recovery. Through comparative jurisdictional performance, the investigation will present best practice mechanisms, highlight disparities, and give timely lessons to policymakers and administrators in healthcare. The analysis presents that smaller provinces like Prince Edward Island and Nova Scotia are more efficient than their larger counterparts, indicating that having more scale does not necessarily provide for optimal use of resources. These results go against conventional wisdom and therefore stress the importance of outcome-oriented planning in rehabilitation policy. Ultimately, this study adds to an increasing number of works on healthcare benchmarking and provides a replicable way of assessing rehabilitation systems in other country contexts.

\* Corresponding author.

E-mail address: [ghousi@iust.ac.ir](mailto:ghousi@iust.ac.ir) (R. Ghousi)

## 2. Literature review

Rehabilitation services come under post-acute care, particularly for patients recovering from a stroke, orthopedic surgery, and neurological conditions. Traditionally, an important focus of evaluation has been functional outcomes, patient satisfaction, and efficiency at the level of the system. Studies by Heinemann et al. (2003) and Stucki & Melvin (2007) stress the importance of standardized outcome measurement such as the Functional Independence Measure (FIM) for defining the level of rehabilitation quality and helping with alternative clinical decision-making.

In Canada, the Canadian Institute for Health Information (CIHI) has developed the National Rehabilitation Reporting System (NRS), which gathers data on inpatient rehabilitation episodes in all ten provinces. This system helps comparative analysis of throughput, length of stay, and discharge outcomes, as highlighted in CIHI's annual Quick Stats reports. Nevertheless, few attempts have implemented quantitative benchmarking tools like Data Envelopment Analysis (DEA) to assess provincial-level efficiency in rehabilitation delivery.

DEA has obtained traction in healthcare performance evaluation due to its capability to cope with multiple inputs and outputs without any need of predefined weights. Past applications in rehabilitation include work by O'Neill et al. (2008), who implemented DEA to evaluate hospital-based rehab units in the U.S., and by Linna et al. (2006), who assessed efficiency across European rehabilitation centers. These studies show DEA's utility in identifying best practices and resource optimization strategies.

Despite its relative potential, DEA is underutilized in Canadian rehabilitation research. This study addresses that gap by integrating CIHI metrics with provincial budget data to evaluate how effectively financial resources are translated into patient throughput and functional recovery—offering a novel framework for policy benchmarking and system improvement.

## 3. The proposed study

The study of this paper implements Data Envelopment Analysis (DEA) to measure the relative efficiencies of 10 provinces in Canada. Table 1 presents the data adapted for the proposed study of this paper.

**Table 1**  
Primary Rehabilitation Efficiency by Province and the budget (2025)

Decision Units	Input		Outputs
	Estimated Annual Budget (B\$ in CAD)	Avg Admissions per Center	Functional Gain (FIM score)
Ontario	1.2	450	25
Quebec	0.500	380	22
British Columbia	0.650	400	23
Alberta	0.580	420	24
Manitoba	0.220	350	21
Saskatchewan	0.180	300	20
Nova Scotia	0.160	310	21
New Brunswick	0.140	290	20
Newfoundland & Labrador	0.130	270	19
Prince Edward Island	0.090	250	20

Source Information: Rehabilitation Efficiency Table – Canada by Province (2025)

Note: Budgets include inpatient rehab, outpatient therapy, and community-based services.

Figures are estimates based on provincial health ministry reports and CIHI rehab allocations.

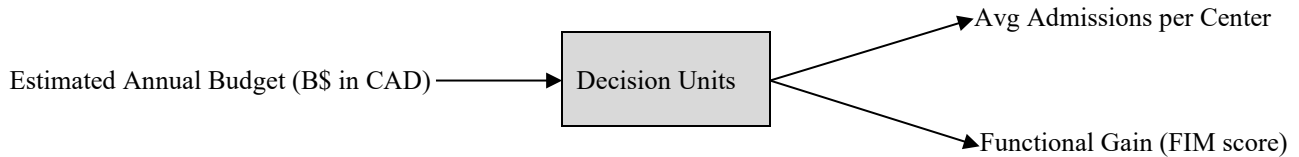
Functional Gain reflects average improvement in mobility, cognition, and self-care.

For the implementation of the DEA method, we have considered Estimated Annual Budget (Billion dollar in CAD) as input and Avg Admissions per Center and Functional Gain (FIM score) as output. In other words

- **Avg Admissions per Center** is associated with the average number of patients accepted to each rehabilitation facility within a province, annually. This factor reflects the center's service volume and throughput capacity for inpatient rehabilitation care.

- **Functional Gain (FIM score)** considers the recovery in a patient's physical as well as cognitive abilities during rehabilitation, based on the Functional Independence Measure. A higher score represents bigger recovery in areas like mobility, self-care, and communication from admission to discharge.

Comparative performance benchmarking is done to see the relative efficiency of each province in converting budgetary input into meaningful rehabilitation throughput and functional improvement, so as to extract and reproduce the best resourcing practices. Fig. 1 shows the structure of the proposed study of this paper.



**Fig. 1** The input/output factors used for the proposed study

DEA is employed for efficiency measurement of rehabilitation centers in 10 Canadian provinces. When measuring inputs, the DEA model uses Input/outputs depicted in Fig. 1. We then use DEA to determine those provinces at the frontier and set the others against them. The nonparametric decision maker assists us to make a comparison in the resource utilization pattern without the comparative assumption of a production function. These results may be implemented for decision-making related to scanner acquisitions, employees, and policy makers for diagnostic capacity in provinces with somewhat lower efficiency scores compared to their peers.

The implication of the proposed study uses four techniques of DEA, as follows (Bagherzadi, 2024),

**CCR Model** (Charnes et al., 1978) is a constant return to scale and measures the efficiency by comparing weighted inputs to outputs.

**BCC Input-Oriented Model** permits variable returns to scale and minimizes input usage while maintaining output levels (Banker et al., 2984).

**BCC Output-Oriented Model** also assumes of variable returns to scale but looks for maximizing outputs given fixed inputs (Cooper et al., 2007).

**Additive Model** measures inefficiency by summing input excesses and output shortfalls without weighting (Charnes et al., 1985; Cooper et al., 2007).

#### 4. The results

In this section, we demonstrate the summary of the implementation of the DEA method for measuring the relative efficiency of provinces.

**Table 2**

The results of the implementation of DEA methods for measuring the relative efficiencies of 10 province for Model 1

Province	CCR	Input oriented BCC	Output oriented BCC	Additive
Ontario	0.1350	1.0000	1.0000	1.0000
Quebec	0.2736	0.7486	0.9421	0.9397
British Columbia	0.2215	0.7341	0.9538	0.9453
Alberta	0.2607	1.0000	1.0000	1.0000
Manitoba	0.5727	1.0000	1.0000	1.0000
Saskatchewan	0.6000	0.8241	0.9471	0.9293
Nova Scotia	0.6975	1.0000	1.0000	1.0000
New Brunswick	0.7457	0.9762	0.9902	0.9886
Newfoundland & Labrador	0.7477	0.8718	0.9497	0.9480
Prince Edward Island	1.0000	1.0000	1.0000	1.0000

Table 2 demonstrates the results of the implementation of the DEA methods for measuring the relative efficiencies of 10 provinces for the model shown in Fig. 1. As we can see from the results, CCR model yields lower scores compared with other methods since Efficiency under CCR = Technical Efficiency  $\times$  Scale Efficiency. So CCR is always  $\leq$  BCC. According to our results, Prince Edward Island represents the best utilized province in terms of the rehabilitation centers followed by Nova Scotia, Manitoba and Alberta. In our survey, Quebec represents lower ratio of efficiency compared with other provinces.

These findings reveal striking regional disparities in how rehabilitation budgets are translated into concrete patient outcomes and service volume. Prince Edward Island, with its modest budget, is spending very efficiently—perhaps smaller systems benefit from tighter coordination and clearer care pathways. The strong showing of Nova Scotia and Manitoba also demonstrates that average-sized provinces may boost throughput without having to raise spending.

## 5. Discussion and Conclusion

The study has demonstrated smaller provinces like Prince Edward Island or Nova Scotia being superior in resource utilization compared to larger provinces. The high efficiency scores of these provinces may reflect the implementation of lean operations, targeted care pathways, and local coordination resulting in better throughput and outcomes, irrespective of scarce funding. Manitoba and Alberta also do very well, suggesting that mid-sized and urban-integrated systems do manage to balance scale with efficiency. Quebec's efficiency score, on the other hand, being lower, raises questions about systemic bottlenecks, administrative overhead, or perhaps mismatch between funding and service delivery. These findings question the preconception that higher budgets automatically create better performances and instead highlights how strategic investment and planning for outcomes matter.

From a policy perspective, this analysis offers a framework within which rehabilitation systems can be benchmarked, and best practices identified. Provinces with lower levels of efficiency may then want to consider adopting models used in regions that fare better, for example, with centralized intake systems, outcome-based funding, or integrated diagnostics digital systems. Future work could extend the model by incorporating more outputs such as patient satisfaction, discharge destinations, or readmission rates, thereby aiming to represent a more comprehensive view of the value of rehabilitation. And so, the study highlights the power of DEA as a decision-support mechanism that healthcare administrators may then use to create strategies that, on the one hand, are fiscally responsible yet, on the other hand, promote better care for the patients.

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