CODEM: a Compliance-Oriented Decomposition Method for Québec Health System Software

by

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CODEM : une méthode de décomposition orientée vers la conformité pour les logiciels du système de santé du Québec

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RESUMÉ

Les professionnels et les gestionnaires de la santé sont confrontés à des défis persistants pour se conformer à de nombreuses réglementations, souvent larges et mal définies. Parallèlement, les gouvernements éprouvent des difficultés à concevoir, mettre en œuvre et faire respecter des politiques efficaces. Ce fossé réglementaire limite l'opérationnalisation des modèles de systèmes de santé et leur gouvernance. Le génie logiciel offre des outils prometteurs pour atténuer ce fossé grâce à l'application des technologies réglementaires (RegTech) et des technologies de supervision (SupTech).

Cette recherche présente la Méthode de Décomposition Orientée vers la Conformité (CODEM) afin de renforcer le respect de la législation québécoise en matière de santé. Elle s'écarte des approches traditionnelles en considérant les exigences légales comme une matière première, qu'elle décompose systématiquement en éléments permettant de créer des indicateurs de conformité et de produire des artefacts numériques tels que des tableaux de bord de gestion.

En s'appuyant sur le cadre conceptuel du Policy Triangle de Walt et Gilson, l'étude avance l'hypothèse selon laquelle les réglementations, à différents niveaux, partagent des composantes fondamentales, comme les acteurs, les sphères et les tâches, qui peuvent être décomposées et classifiées de manière systématique. Cette hypothèse est évaluée à travers deux études de cas portant sur des législations sanitaires en vigueur. Les éléments extraits servent à définir des indicateurs de conformité et à proposer un modèle de données, lequel soutient le développement de deux prototypes fonctionnels de tableaux de bord Power BI. Ces tableaux de bord agrègent l'information selon le niveau stratégique, les caractéristiques des tâches, le type de législation, la sphère décisionnelle et d'autres dimensions pertinentes.

Malgré les limites reconnues, les résultats démontrent la faisabilité et le potentiel de la méthode et du modèle de données proposés pour la recherche et l'innovation futures. Les applications envisagées incluent la classification évolutive par apprentissage automatique, des outils de conformité centrés sur l'utilisateur, des représentations hiérarchiques multiniveaux, un soutien accru à l'ingénierie des exigences et des versions numériques structurées des politiques de santé pour favoriser l'interopérabilité.

Mots-clés: Technologie réglementaire; RegTech; Technologie de supervision; SupTech; Conformité réglementaire en santé.

Codem: a compliance-oriented decomposition method for Québec health system software

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ABSTRACT

Health professionals and managers face persistent challenges in complying with numerous and broadly defined healthcare regulations. Simultaneously, governments struggle to design, implement, and enforce effective policies. This regulatory gap constrains the operationalization of health system models and governance. Software engineering offers promising tools to mitigate this gap through the application of Regulatory Technology (RegTech) and Supervisory Technology (SupTech).

This research introduces the Compliance-Oriented Decomposition Method (CODEM) to enhance adherence to Quebec's healthcare legislation. It departs from traditional practices by treating legal requirements as raw material, systematically breaking them down into elements that can create compliance indicators and produce digital artifacts such as management dashboards.

Using Walt and Gilson's Policy Triangle Framework, the study hypothesizes that regulations across distinct levels share core components, like actors, spheres, and tasks, which can be decomposed and systematically classified. This hypothesis is evaluated through two case studies involving active healthcare legislation. The extracted elements inform the creation of compliance metrics and a data model, which supports the development of two functional Power BI dashboard prototypes. These dashboards aggregate information by strategic level, task characteristics, legislation type, decision sphere, and other relevant dimensions.

Despite acknowledged limitations, the findings demonstrate the feasibility and potential of the proposed method and data model for future research and innovation. Applications include scalable classification via machine learning, user-centric compliance tools, multilevel hierarchical representations, enhanced support for requirements engineering, and digitally structured health policies to improve interoperability.

Keywords: Regulatory Technology; RegTech; Supervisory Technology; SupTech; Healthcare regulatory compliance.

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LIST OF ABREVIATIONS AND ACRONYMS

CIUSSS	Centres Intégrés Universitaires de Santé et de Services Sociaux
CODEM	Compliance-Oriented Decomposition Method
DLT	Distributed Ledger Technology
DRSP	Direction Régionale de Santé Publique
DTD	Dynamic transaction documents
EA	Enterprise Architecture
ML	Machine Learning
RegTech	Regulatory technology
SDLs	Scientific database libraries
SupTech	Supervisory Technology
WHO	World Health Organization
SVO	Subject Verb Object
MSSS	Ministère de la Santé et des Services Sociaux

INTRODUCTION

This chapter presents the research, providing a clear overview of its scope and objectives. It begins by situating national health systems within their broader context and emphasizing the critical role of software engineering in addressing their challenges. From this foundation, the research motivation is defined, followed by a precise statement of the problem. The central research question and the proposed solution are then introduced, establishing the framework for investigation. The study's testable hypothesis is formulated and its operationalization described through a structured methodology. The anticipated contributions are outlined, underscoring the study's relevance and potential impact. The chapter concludes with a thesis outline, serving as a roadmap for the remainder of the dissertation.

Contextualization

Software engineering is a well-established discipline focused on managing complexity through rigorous methods that integrate diverse stakeholder requirements while ensuring compliance with documentation standards and regulations. It has demonstrated the capacity to manage information efficiently, generate actionable insights, and provide effective mechanisms for complexity reduction and regulatory adherence across multiple industries. Nevertheless, software systems themselves remain inherently complex. (Brooks & Kugler, 1987).

Maximizing the strengths of software engineering requires ongoing research to identify, adapt, and validate the most effective methodologies. Over recent decades, these practices have evolved to address increasingly complex challenges in sectors such as financial services, aerospace, and others. Today, they are essential in domains like healthcare, where reliable information and knowledge management are critical. In this context, the role of software engineering extends beyond implementing products and services such as electronic health records. A major challenge lies in sustaining the governance of health systems, a responsibility typically held by government bodies and administrators. This governance increasingly depends on information systems designed to meet the sector's specific needs.

There is no single concept of what constitutes health systems governance (Pyone, Smith, & van den Broek, 2017). For the World Health Organization (WHO), “health systems governance refers to the processes, structures and institutions that are in place to oversee and manage a country's healthcare system. It manages the relationships between different actors and stakeholders involved in healthcare, including government agencies, healthcare providers, patients and their families, people and communities, civil society organizations and private sector entities” (World Health Organization, 2025a).

The WHO health-system performance framework (European Observatory on Health Systems and Policies, 2022) ranks governance alongside financing, resource generation and service delivery as a core function. Governance breaks down into four interrelated pillars: policy and vision, which define a clear strategic direction and accountability mechanisms; stakeholder voice, which ensures that patients, providers and communities shape priorities; information and intelligence, which drives data-informed decision making; and legislation and regulation, which establish the legal foundations and standards. Together, these elements determine how effectively a system governs its financing, services and resources to achieve health goals.

Policy compliance underpins transparency, accountability and progress toward health system goals (European Observatory on Health Systems and Policies, 2022). Achieving compliance is daunting in environments defined by thousands of interdependent processes, diverse stakeholders and competing priorities. This gap between policy design and everyday practice helps explain why real-world systems often stray from the models’ governments envision. Healthcare managers, professionals and institutions grapple daily with complex evolving regulations, while governments face persistent challenges in crafting, implementing and enforcing effective policies.

Research Motivation

One of the greatest challenges in managing the technological infrastructure of a healthcare system, such as Quebec's, is achieving coordination and integration. According to the provincial government, the sector comprises approximately 1,600 facilities of varying sizes and missions, nearly 4,000 community organizations, and hundreds of clinics and private practices employing over 300,000 professionals. These professionals depend on about 10,000 information systems and 65,000 interconnected technological devices that support the province's healthcare operations. This infrastructure continues to expand annually (Québec, 2022).

The COVID-19 pandemic in 2020 tested the Québec healthcare system, revealing significant vulnerabilities in governance, integration, and the efficiency of its digital infrastructure. During this period, unclear information and persistent uncertainty over whether the federal or provincial government was responsible for specific policies hindered coordinated action nationwide. These ambiguities underscored the need to clarify responsibilities and align priorities between the provincial government and major municipalities (Alami et al., 2021).

This period served as a catalyst for strategic initiatives at the provincial level, aimed at addressing identified shortcomings and strengthening the healthcare system's capacity to confront future challenges. As stated by the government: "These systems and devices need to be integrated and orchestrated to provide (…) accurate and quality information obtained in a timely manner (…) essential for the effective management of the health and social services network" (Québec, 2022).

The province has been advancing the standardization and integration of electronic health records to align with established interoperability standards and modernize its IT infrastructure. These initiatives are essential to supporting the province's comprehensive digital transformation of its healthcare system. At the same time, they present an opportunity to leverage technological innovation to strengthen the governance of Québec's health system.

A key requirement for managers at various levels is ensuring compliance with legislation. Health-related laws are numerous and dynamic, involving amendments and developments that must be monitored in the correct sequence and timeframe. Some stakeholders face challenges in interpreting legislation, whether due to the complexity of the language or the level of abstraction in decisions, which often specify what must be done but not how to do it, details that are addressed at lower levels of the system. Role definitions may also present gaps, overlaps, or even conflicting guidelines across different jurisdictions. Furthermore, uncertainty may persist regarding the actual level of compliance achieved in practice compared to the recommended model. Tools that enable technically sound verification of compliance, along with visualization of the health system's configuration and its components, are valuable assets for effective management.

The health manager must ensure compliance with legislation when overseeing the provincial health system (Canada, 2024), while also coordinating service delivery and maintaining effective communication with other jurisdictions. However, much of the information available is not readily accessible (Alami et al., 2021). It originates from various assistance sources and is dispersed across an extensive service network with differing levels of technological maturity and interoperability (Québec, 2022). Portions of the decision-making process and compliance verification still rely on manual, process-dependent work.

In view of the context presented, regulatory compliance has become a rapidly expanding research domain. Recent studies emphasize the critical role of software in enabling organizations to meet legal requirements, while also noting that dedicated compliance tools remain at an early stage of development (Gyory, Amariles, Lewkowicz, & Bersini, 2023).

This research examines the potential of software engineering methods to address this critical challenge in healthcare. The primary motivation is the recognition that academia can play a pivotal role in closing this gap by developing innovative solutions that enhance regulatory adherence and strengthen policy enforcement.

Research Delimitation

Based on the previously presented context and motivation, we proceeded to define the research problem and propose a solution. We also included the main research question and its hypothesis, concluding with a research statement and an assessment of the type of research conducted.

Research Problem

Québec's health managers, professionals, and institutions face challenges in complying with numerous and broadly defined regulations, while governments encounter difficulties in designing, implementing, and enforcing effective policies. This gap could limit the practical implementation of the health system model and weaken system governance. Software engineering methods can help reduce this gap.

Proposed Solution to Research Problem

This research proposes a **method** for systematically transforming Québec's health legislation into actionable compliance metrics and digital dashboards, specifically tailored to the needs of health managers and operational teams. For ease of reference, this method will hereafter be referred to by the acronym **CODEM** (Compliance-Oriented Decomposition Method).

Main Research Question

The main research question can be summarized in the following expression: *How can policies be incorporated into digital metrics and representations to support compliance and governance within Québec's health system?*

Research Hypothesis

We hypothesize that Quebec's health legislation contains core policy elements (actors, spheres, tasks) that can be systematically extracted and classified, with a high conversion rate of the original legislative expressions and then encoded as metrics to support regulatory compliance and enable interactive governance dashboards.

To facilitate the investigation, this hypothesis was divided into two testable sub-hypotheses (SH):

SH1 - Quebec's health legislation contains core policy elements (actors, spheres, tasks) that can be systematically extracted and classified.

SH2 - [These core policy elements] can be encoded as digital metrics to support regulatory compliance and enable interactive governance dashboards.

Statement of Research

This research proposes a structured method, the CODEM, to decompose health policies into actors, spheres and tasks, using these elements for modeling compliance metrics and dashboards, to support regulatory compliance in Québec.

Study Classification

This study adopts a qualitative research design, employing two case studies to develop the Compliance-Oriented Decomposition Method.

Contributions of Research

This research makes two contributions. First, it introduces CODEM, a basic, systematic, and operational method for decomposing health legislation into quantifiable elements that can be embedded into digital artifacts. Translating legislation into a structured and interconnected format offers significant value for a broad range of stakeholders, including policymakers,

regulators, managers at all levels, healthcare teams, and software developers. It also creates opportunities for further research, as discussed in Chapter 6.

Second, it presents a data modeling proposal (Chapters 3 and 4) based on a well-established framework from the legal analysis literature. This model can serve as a foundational reference for developers designing new software systems and digital platforms for the healthcare sector, with both tactical and strategic applications.

Thesis Outline

This work is organized to enhance the reader's understanding of both the methodological and contextual dimensions of the research, while maintaining a strong focus on transparency and reproducibility.

Chapter 1 offers a comprehensive literature review, identifying key concepts that form the theoretical foundation of the study. Chapter 2 outlines the method, detailing the procedures followed and the precautions taken at each stage of the investigation. Chapters 3 and 4 present two case studies examining specific pieces of legislation from Québec, providing a systematic account of the methodology applied and the corresponding results. Chapter 5 revisits and analyzes these findings in relation to the central research question. The final section consolidates the main conclusions, highlighting their implications for future research and potential applications in practice.

CHAPTER 1

BACKGROUND

This chapter is organized into two parts. The first outlines the literature review method and results, providing a concise overview of the main findings on the research topic. The second presents key concepts that constitute the foundational body of knowledge applied in the subsequent chapters.

1.1 Literature Review Methodology

Three key questions guided the literature review:

Q1 – What methods and technological tools are used to support governments and businesses in complying with legislation?
Q2 – What is the current level of maturity and state of knowledge in research within this field?
Q3 – How has this knowledge been applied in the healthcare sector to address governance challenges?

To address these questions, we adopted a three-phase approach. First, we searched for primary and secondary studies using combinations of keywords related to technological tools, methods, compliance, and legislation (Q1), establishing a foundation for identifying relevant works across multiple domains. Based on these initial findings, we examined systematic reviews and mapping studies to gain a broader and more structured understanding of the field (Q1, Q2, Q3). Finally, the insights from the previous phases were used to identify specific, in-depth studies focused on the healthcare sector, particularly those addressing governance-related challenges (Q3).

Phase 1 – Exploratory phase (Generic Term Search)

This phase comprised five steps. The first was constructing a generic search query that combined keywords from three distinct expressions: tools and methods (E1), compliance (E2), and legislation (E3), as illustrated in Algorithm 1.1. We used five scientific database libraries (SDLs) to retrieve relevant publications. Three of these: Scopus, the ACM Digital Library, and the IEEE Xplore Digital Library, are well established in software engineering. To broaden the scope, we also included Google Scholar and MEDLINE, a specialized database for biomedical literature. To enhance reproducibility, the complete version of each specific search expression used in each SDL is provided in Appendix X.

Algorithm 1.1 Generic Search Query Expression

(E1) "Tool" OR "software" OR "technology" OR "system" OR method* OR approach* OR techniq* OR framework* OR strateg* OR model* OR algorithm* OR process* OR architecture*

AND

(E2) "Adherence" OR "Conformity" OR "Conformance" OR "Observance" OR "Regulatory compliance" OR "Legal compliance" OR "Accountability" OR "Compliance"

AND

(E3) "Law" OR "Statute" OR "Act" OR "Bill" OR "Code" OR "Ordinance" OR "Regulation" OR "Directive" OR "Decree" OR "Policy" OR "Lawmaking" OR "Legal framework" OR "Written law" OR "Legal code"

The second step involved applying additional search parameters to refine the results, including publication type, language, research area, and time frame, as detailed in Table 1.1.

Table 1.1 Filters with Specific Parameters for Search Engines

SDL	Time period	Language	Publication Type	Publication Field
Scopus	Last 10 years	English	Journal; conference proceeding; conference paper; review	Computer Science; Engineering; Business, Management and Accounting; Decision Sciences; Multidisciplinary; Health Professions
IEEE Explorer	Last 10 years	English	Journal; conference; Early Access Articles	All
ACM Digital Library	Last 10 years	All	Journal; conference; Early Access Articles	All
Google Scholar	Last 10 years	English	All	All
Pubmed	Last 10 years	English	All	All

The third step involved excluding studies unrelated to the research topic, based on a review of their titles and a preliminary scan of their abstracts. The remaining works, including those with titles that raised doubts, had their abstracts examined in detail during the fourth stage. This process resulted in a list of texts selected for full reading, which were also used to help identify additional relevant works in the next phase. Table 1.2 presents the number of items retrieved at each stage.

Table 1.2 Number of articles retrieved according to each step of this phase, as discussed in the text. The reference ID is the same final selection of articles

SDL	1st	2nd	3rd	4th	References ID
Scopus	1,113	319	24	8	*6,9,11,12,13,14,15,17*
IEEE Explorer	77	42	4	2	*2,14*
ACM Digital Library	90	56	3	2	*18,19*
Google Scholar	68	30	0	0	-
PubMed	105	50	0	0	-
Total	**1,816**	**861**	**31**	**12**	-

Several important lessons emerged during this phase. First, the low number of relevant studies retrieved indicated that the keyword-based search strategy combining tools and methods, compliance, and legislation (E3) was too broad and imprecise. Second, research on this topic

within the healthcare sector proved relatively scarce. Third, and most importantly, analysis of the retrieved articles revealed two correlated domains of study related to technology for regulatory compliance: supervisory technology (SupTech) and regulatory technology (RegTech). This finding enabled the development of a more targeted search strategy, further explored in phase 2 of the legislation-focused research.

Phase 2 – Literature search for secondary studies

Having identified the domain of interest in phase 1, the next step was to refine the search expression. The initial focus was on identifying systematic reviews and mapping studies related to the topic before proceeding to search for primary studies. These secondary studies often serve as valuable starting points due to the methodological rigor typically applied in their development. To construct the search expression, we followed the strategy recommended by (Napoleao et al., 2021), combining keywords specific to the area of interest with terms intended to capture secondary studies (algorithm 1.2).

Algorithm 1.2 Secondary Studies Specific Query

(("SupTech" OR "Supervisory Technology" OR "RegTech" OR "Regulatory Technology")

AND

("literature review" OR "systematic mapping" OR "systematic review" OR "mapping study" OR "systematic map"))

The selection process began by filtering publications written in English and limited to journal articles and conference proceedings. To broaden the scope, no restrictions were applied to the publication period. A preliminary screening of titles and abstracts was then conducted to assess thematic relevance. Finally, the articles deemed most pertinent to the research objectives were selected. The results of this process are presented in Table 1.3, and the key findings are summarized in the following section of this chapter.

Table 1.3 Number of secondary studies retrieved according to each step of this phase, as discussed in the text. The reference ID is the same final selection of articles

SDL	1st	2nd	3rd	4th	Ref ID
Scopus	20	15	11	4	*1,2,3,5*
IEEE Explorer	13	12	3	1	*2*
ACM Digital Library	5	0	0	0	-
Google Scholar	7	7	5	2	*1,3*
Pubmed	0	0	0	0	-
Total	1,816	861	31	7	-

In the case of the ACM Digital Library, searches were conducted separately within the title, abstract, and author keyword fields. The value shown in Table 1.3 refers specifically to the title-based search. The abstract search proved entirely non-specific, while the keyword search returned no results. For Google Scholar, priority was given to entries where at least one keyword from the first expression and one from the second expression appeared in the title. The Medline database returned no results. Detailed search expressions are provided in Appendix X.

Phase 3 – Health Domain Term Search

This phase focuses on locating studies that apply the research topic within the health domain.

In Step 1, the search string builds upon the Phase 2 query by replacing specific secondary study identifiers with broader health-related terms such as health, medic, or MedTech, while retaining the emphasis on “SupTech” and “RegTech” (see Algorithm 1.3).

Algorithm 1.3 Secondary Studies Specific Query

(("SupTech" OR "Supervisory Technology" OR "RegTech" OR "Regulatory Technology")
AND
(health* OR medic* OR MedTech))

Step 2 applies language restrictions, limiting results to English-language articles without imposing any publication date constraints. Searches are conducted across titles, abstracts, and keywords, except in Google Scholar, where only titles and full-text content are searched to minimize the retrieval of overly broad FinTech results. The primary inclusion criterion is the presence of at least one relevant reference to a technological application within the health domain, appearing in either the title or abstract. In Step 3, abstracts are screened for relevance, followed by a full-text assessment in Step 4. The final search results are summarized in Table 1.4.

Table 1.4 Number of articles retrieved according to each step of this phase, as discussed in the text. The reference ID is the same final selection of articles

SDL	1st	2nd	3rd	4th	Ref ID
Scopus	23	23	04	02	*07,08*
IEEE Explorer	03	03	00	00	-
ACM Digital Library	73	73	05	00	-
Google Scholar	05	05	01	00	-
Pubmed	05	02	00	00	-
Total	109	106	10	02	-

Literature Review Final Results

The final set of selected articles is presented in Table 1.5. The complete reference for these articles can be found in the List of References at the end of this work.

Table 1.5 Final Selection of Articles

Ref Id	Reference	Document Title
1	(Benny Firmansyah & Arry Akhmad Arman, 2022)	A Systematic Literature Review of RegTech: Technologies, Characteristics, and Architectures
2	(Ardiansyah & Arman, 2022)	Regulation Compliance Supervision Technology: A Bibliometric Analysis
3	(Mayasari & Arman, 2022)	SupTech Governance in Regulatory/Supervisory Government Agencies: A Systematic Literature Review
4	(Financial Stability Board, 2020)	The use of supervisory and regulatory technology by authorities and regulated institutions: Market developments and financial stability implications
5	(Grassi & Lanfranchi, 2022)	RegTech in public and private sectors: the nexus between data, technology and regulation
6	(Zhang, Nisbet, Ma, & Broyd, 2023)	A multi-representation method of building rules for automatic code compliance checking
7	(Bergmann, 2022)	The Emerging Field of Medical Regulatory Technology and Data Science
8	(Firmansyah & Arman, 2023)	Generic Solution Architecture Design of Regulatory Technology (RegTech)
9	(Adams, Augusto, Davern, & La Rosa, 2024)	End-to-end, no-code business process compliance framework for the banking industry
10	(Adams, Augusto, Davern, & Rosa, 2024)	Apromore Compliance Center: A No-Code Solution to Process Compliance Management
11	(Bartolini, Lenzini, & Robaldo, 2019)	The DAta Protection REgulation COmpliance Model
12	(Bella, Castiglione, & Santamaria, 2023)	An Ontological Approach to Compliance Verification of the NIS 2 Directive
13	(Bukša, Darģis, & Penicina, 2015)	Towards a method for integrated semi-automated business process and regulations compliance management for continuous requirements engineering
14	(Elluri, Chukkapalli, Joshi, Finin, & Joshi, 2021)	A BERT based approach to measure web services policies compliance with GDPR
15	(Fernandez & Yimam, 2015)	Towards compliant reference architectures by finding analogies and overlaps in compliance regulations
16	(Gyory et al., 2023)	Ant: a process aware annotation software for regulatory compliance
17	(Hassani, 2024)	Enhancing Legal Compliance and Regulation Analysis with Large Language Models
18	(Kokaly, Salay, Sabetzadeh, Chechik, & Maibaum, 2016)	Model management for regulatory compliance: a position paper
19	(Sunkle, Kholkar, & Kulkarni, 2015)	Model-driven regulatory compliance: a case study of "know your customer" regulations

1.2 Literature Review Findings

This work is situated in the domain of technologies for regulatory compliance. This domain is divided into two subdomains: Regulatory Technology (RegTech) and Supervisory Technology (SupTech).

Regulatory and Supervisory Technology

"RegTech" refers to technology, particularly information technology, applied in the context of regulatory compliance, including tasks such as risk management (Armstrong & Harris, 2019). It focuses on the tools and systems employed by companies and other entities to meet standards and regulations. In contrast, "SupTech" denotes the technology used by supervisory authorities, emphasizing the regulatory perspective of governments and their institutions.

RegTech and SupTech have demonstrated applicability across various sectors, including healthcare. However, historical and practical factors, such as the urgency to address economic crises like the 2008 financial collapse and the pace of regulatory expansion, have led most studies to focus on financial applications, commonly framed under the term "FinTech." This domain has attracted extensive scholarly attention, resulting in numerous publications, including systematic reviews and mapping studies. Consequently, many authors treat RegTech and SupTech as synonymous with FinTech, often using the terms interchangeably.

In a recent systematic review, with emphasis also on financial applications, the authors (B. Firmansyah & A. A. Arman, 2022) highlighted four frequently cited characteristics of RegTechs: agility, speed, integration, and analytics. They applied layers of enterprise architecture (EA) to define four architecture layers of RegTechs: business, data, application, and technology architectures.

Business architecture includes processes, functions, outcomes, and organization. Data architecture supports business architecture by managing both structured and unstructured data required by applications, including customer, transaction, regulatory or rule, financial report,

public information source, and risk data. Data activities can be grouped into four general categories: collection, processing, analytics, and visualization.

Application architecture addresses software requirements such as regulatory information retrieval, machine-readable translation of rules, autonomous analysis and real-time monitoring, simplified updates to regulations, automated compliance and reporting, digital identity authentication, and dynamic transaction documents.

Technology architecture defines the models that determine how software is built, distributed, and maintained. This layer includes advanced distributed computing, decentralized data and storage management, cloud-based services, data warehouses and lakes, service-oriented and distributed software architectures, microservices, and both service-based and web-based applications. More than 18 functional and analytical technologies support approaches to complex data, security, automation, and decision-making, with the most frequent including blockchain, artificial intelligence and machine learning (ML), distributed ledger technology (DLT), and big data analytics (Benny Firmansyah & Arry Akhmad Arman, 2022).

In the SupTech domain, (Ardiansyah & Arman, 2022) emphasize that regulations establish standards required for services to align with policies set by regulators. They found that evaluation studies on supervisory technology remain scarce. Nonetheless, interest in regulatory compliance monitoring has increased over time, driven largely by financial and business literature. Given the substantial research gap, they advocate further exploration of how current technologies can support compliance monitoring beyond the financial sector and inform the design of effective SupTech architectures. Although most available studies focus on RegTech, particularly within the FinTech domain, "Research related to RegTech is still little found in computer science journals" (Benny Firmansyah & Arry Akhmad Arman, 2022).

RegTech and SupTech in Healthcare

Regarding the application of RegTech and SupTech in the healthcare sector, our findings were vague and generally limited to brief references within broader FinTech studies exploring the potential for innovation in adjacent fields.

In an editorial on the emerging field of medical regulatory technology, (Bergmann, 2022) examines the dual role of legislation in healthcare, functioning both as a barrier and a catalyst for innovation. The author argues that a deeper understanding of legal frameworks can help mitigate the regulatory challenges that often impede progress. It also notes that RegTech can be applied to enhance compliance or maintain regulatory standards at a lower cost, both outcomes being highly beneficial for professionals in medical technology. At the time, the author observed a lack of dedicated research on RegTech within the medical domain and proposed the term “MedRegTech” to define this nascent area. Furthermore, the editorial emphasizes that this type of research could provide policymakers with objective and critical insights, particularly by analyzing the complexity of regulations and offering new ways to make them more user-friendly, a prospective result of the current investigation.

The elements presented in this section show that RegTech and SupTech are relatively recent research fields with growing interest within Information Technology. Their application in areas outside the financial sector, especially in healthcare, remains a largely untapped potential within academic research. This gap is significant, and the present study aims to contribute to the foundation for future research on the topic.

1.3 Complementary Concepts

This section builds upon the introduction by presenting additional foundational concepts that support the interpretation of the study’s findings. Reviewing it is **optional**, particularly for readers already familiar with the topic. Its inclusion serves a critical purpose: to clarify the domain in which software engineering contributions are examined throughout this work.

Without this contextual framing, the risk of misinterpretation increases substantially. It is also important to note that the content intersects with other domains beyond software engineering.

Health and healthcare

Health and healthcare are distinct concepts, although they are often used interchangeably in some contexts. According to the WHO, health is "a state of complete physical, social and mental well-being, and not merely the absence of disease or infirmity" (Nutbeam & Muscat, 2021). Healthcare would be the set of health care actions, made possible through the various existing services. In this work, we are using health referring to the healthcare area.

Health System

The ultimate objective of healthcare is improving the quality of care provided, while simultaneously reducing costs (Weber-Jahnke, Price, & Williams, 2013), which is normally done through formally constituted health systems. According to the WHO, a health system consists "(…) of all the organizations, institutions, resources and people whose primary purpose is to improve health" (World Health Organization, 2010).

At the national level, health systems are typically referred to as National Healthcare Systems. However, in many countries, including Canada, healthcare is also administered at the provincial level. Canada's public healthcare system is known as Medicare, but each province manages its own delivery and organization of services. In Quebec, the system is generally referred to as the Quebec Health and Social Services System (*Système de Santé et de Services Sociaux du Québec*), reflecting its integrated approach to both health and social care.

Legal Framework

There are numerous definitions in literature regarding terms related to legislation, varying not only by author but also by region and domain (such as the legal field or the healthcare sector). A deep exploration and debate on this topic fall outside the scope of this work. However, the diversity of studies in this area, with definitions that are sometimes divergent or

complementary, may create confusion for readers unfamiliar with the subject. Therefore, adopting a set of operational definitions is essential, as it serves as the foundation for the methodology developed in this study.

The concepts outlined in this study are primarily based on definitions established by the WHO, the Government of Canada, and the Government of Québec. In the healthcare sector, the most frequent terms include *legislation, laws, acts, bills, health policies, regulations, norms, strategies, action plans, decrees, administrative orders, programs, services, and actions*. Within a health system, many of these instruments follow a hierarchical structure, as illustrated in Figure 1.1.

Legislation is a broad term. Government of Canada considers that "*legislation*, also known as the *acts*, are forms of *law* that can provide the authority to make regulations. *Public health legislation* "includes the institutional capacity to formulate health legislation, especially public health laws and regulations that enable actions to prevent disease, and protect and promote public health by ensuring proper, consistent and timely compliance with the regulatory and enforcement frameworks" (World Health Organization, 2025b).

Generally, legislation begins as a *bill* (draft form). For a bill to become law in Canada, it must be approved by both the House of Commons and the Senate, and by the Governor General of Canada (the Crown)" (Canada, 2017).

Policy is another broad term that is widely used. It consists of "set of statements of principles, values and intent that outlines expectations and provides a basis for consistent decision-making and resource allocation in respect to a specific issue*"* (Canada, 2021).

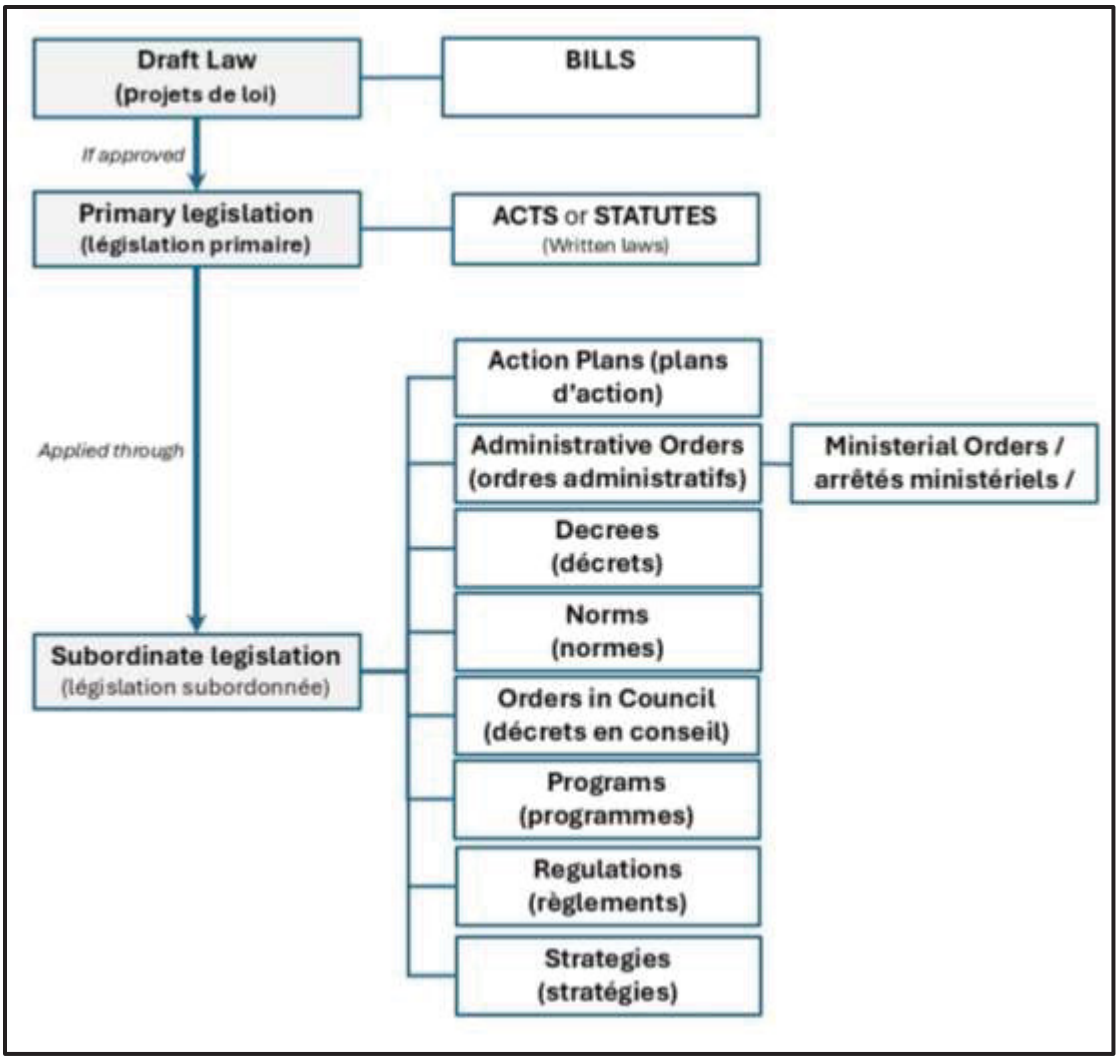

Figure 1.1 Interpretation of Canada's Three-Layer Legislation Structure by the Author

Public policy represents a distinct category of policy that encompasses both the broad objectives guiding government action and prevailing views on the most effective methods for achieving them. More specifically, it refers to the concrete initiatives authorities undertake to meet one or more defined goals. The term "policy" itself carries two primary meanings: it can denote administrative policy, which covers the rules and procedures governing how actions are executed, or substantive policy, which describes the actual content of governmental programs. Analyses of public policy routinely engage with both dimensions (Bernard, 2014).

Health policy constitutes a specialized branch of public policy focused on the choices, strategies, and interventions aimed at realizing defined healthcare objectives within a population. It typically takes the form of an official statement or procedural framework, most often issued by government bodies that sets out priorities, establishes timelines, and delineates the scope of action considering community health needs, resource constraints, and political dynamics. These policies are routinely adopted through legislation or regulatory instruments, which create the rules, standards, and incentives necessary to organize, fund, and ensure access to health services and programs (Nutbeam & Muscat, 2021).

Regulations can be understood as "(…) a form of law, sometimes referred to as subordinate legislation, which defines the application and enforcement of legislation". *Guidelines* are "departmental documents that are used to interpret legislation and/or regulation" (Canada, 2017).

A general observation is that the closer a publication is to the Act level, the more generic its content tends to be. Conversely, as the focus shifts toward actions and services, the content becomes increasingly operational and task oriented. Therefore, any methodology seeking to address the full spectrum of legislation must be capable of navigating effectively between these two poles.

In conclusion, this study uses the terms *legislation, health policies*, and *policies* interchangeably for the sake of didactic simplicity. *Bills* are excluded from this scope, as they denote preliminary drafts governed by a separate development process. The term *Act* applies solely to specific statutes. *Norms, strategies, action plans, decrees, administrative orders and program*s serve as concrete instruments for implementing health policies; these are often referred to collectively as *subordinate legislation* or *policy instruments*. Although they frequently originate from statutory provisions and provide guidance on complying with regulations, they do not carry the force of law. Instead, they direct the actions and services that directly affect healthcare beneficiaries.

CHAPTER 2

METHODOLOGY

This chapter presents the research methodology, emphasizing transparency and reproducibility, and establishing the foundation for the subsequent chapters. Its purpose is to provide readers with a clear and straightforward understanding of the methodological steps undertaken in the study.

Section 2.1 offers a concise overview of the methodology, enabling a quick yet comprehensive grasp of the proposed approach. Sections 2.2 through 2.9 then examine each methodological phase in detail, supplemented with illustrative examples that enhance depth and clarity.

2.1 Overview

The main contribution of this work is a method that, to facilitate communication throughout this dissertation, will from now on be referred to by the acronym CODEM (Compliance-Oriented Decomposition Method).

The CODEM consists of eight well-defined steps, outlined as follows. First, a set of active health policies is identified based on the place of interest (1). Next, a single policy is selected (2), systematically prepared for classification (3), and then classified (4). Subsequently, compliance indicators are defined (5), and the necessary information is gathered (6) to support the calculation of these indicators (7). Finally, the compliance outcomes are presented to stakeholders in the form of digital artifacts (8), marking the conclusion of the process. Figure 2.1 provides a detailed visual representation of these steps.

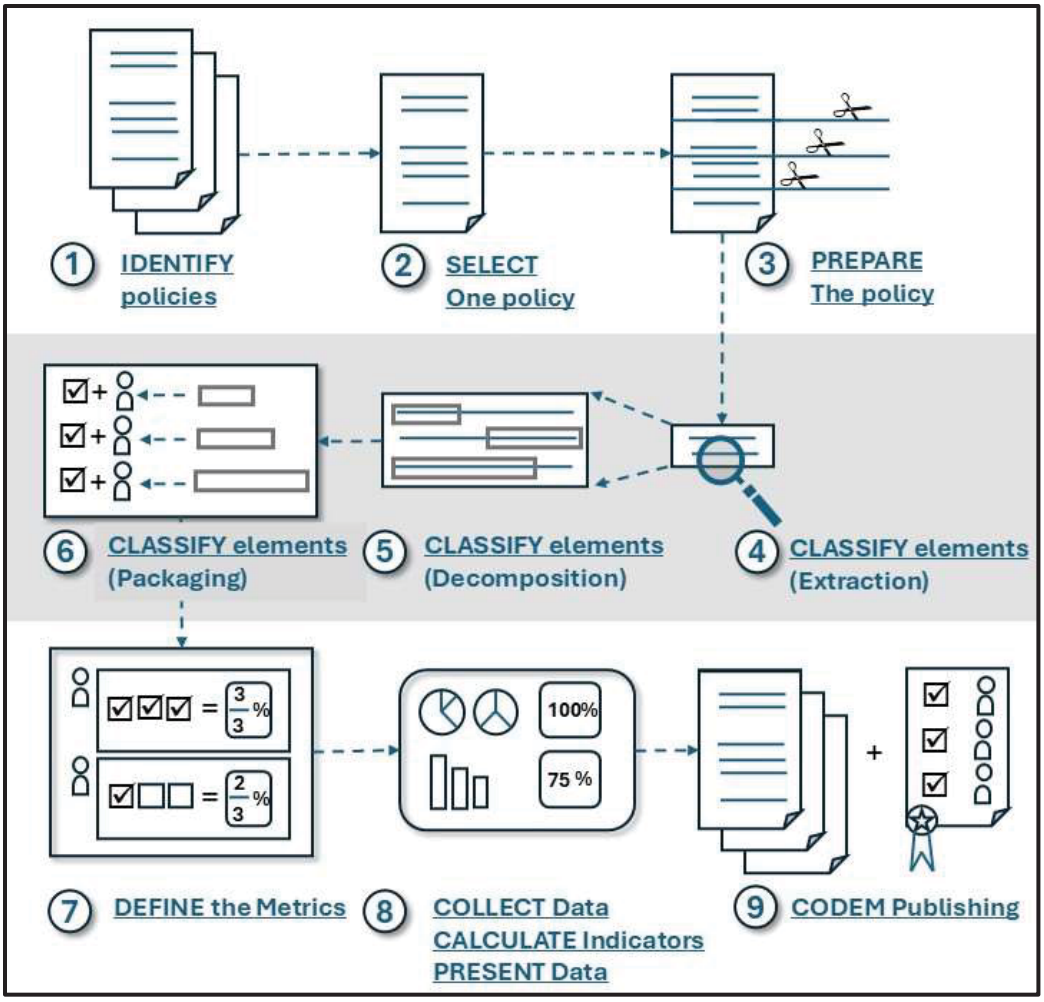

Figure 2.1 Conceptual Overview of the CODEM Phases

Identification (1) requires the user to delineate the legislative scope by precisely specifying which policies to include and which to exclude, then listing all policies that satisfy these criteria. For example, policies published by provincial or federal governments may be relevant or irrelevant to the operation of the local Quebec health system. Legislation from neighbouring provinces may prove pertinent or not depending on the intended purpose. This delimitation is currently carried out manually through consultation of search tools and official publications.

Selection (2) involves selecting each policy individually for processing, since CODEM handles one policy at a time. In practical terms, this means retrieving the most recent digital version of each policy from an official source.

Preparation (3) entails structuring the content of each chosen policy in a digital format that facilitates subsequent classification. The selected format is a matrix in which each paragraph of interest occupies its own cell. Each cell must contain a single central idea or topic. Because published legislation often bundles multiple ideas within one paragraph, large paragraphs are subdivided into smaller ones, each bearing its own focus, and placed into separate cells. Implicit subjects of actions are made explicit at this stage, and purely informational content that does not convey a task or assignment is flagged for exclusion from classification.

Classification (4) forms the core of CODEM and divides into three phases that guide the transformation of cell content into structured data: extraction, decomposition and packaging. Extraction refers to the process of isolating specific passages from their original legislative context and interpreting them based on their meaning. The goal is to identify and separate the elements that are relevant and meaningful for classification purposes.

Decomposition (5) of expressions requires an examination of each matrix cell to break its text into elements following the "subject, verb, object" structure (SVO), common to English, French and many other languages. Since policies adhere to this linguistic pattern, deconstructing them in reverse is relatively straightforward. Each cell typically yields one or two SVO expressions, all of which must be clearly identified. In CODEM, decomposition means that every cell expression is classified into an ACTOR (subject), an ACTION (verb) and an OBJECT. The combination of action and object is designated by CODEM as a TASK. Each actor is then assigned to a SPHERE corresponding to its hierarchical level within the political organization (for example, federal, provincial or municipal). Once actors and their spheres are established, they are categorized into one of three ROLES (Definer, Performer or Receiver). Tasks are subsequently classified according to their practical purpose (informative, active or passive) and by organizational level (strategic, tactical or operational).

Packaging (6) links each extracted expression to its full set of classification attributes in a consolidated record. This ensures that every expression remains associated with its original text and complete metadata, facilitating subsequent interpretation and use by end users and digital systems.

Quantification (7) uses the classified expressions to create new measures of compliance or to integrate with existing performance indicators.

Representation (8) employs the classification elements and their associated metrics as raw material for building digital tools aimed at managers and health teams. Tasks and their metrics typically appear as indicators or KPIs and are displayed in aggregations aligned with user requirements. The various classification elements (actors, spheres and tasks) and their related attributes, practical and organizational purpose and type of legislation, serve as filters for selecting, aggregating and ordering the information.

Publication (9) is optional and refers to the legislator's action of making an additional version of the newly enacted legislation, classified by CODEM, electronically available to all stakeholders and systems. This represents a potential avenue for future implementation, as outlined in the conclusion.

Each of the previously presented steps will now be explored in greater depth, with additional examples.

2.2 Identify Policies

CODEM requires a comprehensive analysis of all active health-related legislation. However, given the complexity and breadth of a country’s legal framework, developing an exhaustive strategy for selecting health policies falls outside the scope of this study. Instead, we opted for a manual survey of existing policies to identify two suitable candidates for the case studies.

To support this process, internet-based research using reliable sources was essential, particularly those maintained by regulatory bodies for publishing and updating current legislation. In this regard, the official website search tools from the Government of Canada (Canada, 2025) and the Government of Québec (Légis Québec, 2025) were utilized, along with official reports and institutional websites. Legislation from all levels of government was considered eligible, with the exception of bills such as those published by the National

Assembly of Québec, since they are regarded as preliminary drafts of legislation and follow a distinct analytical framework.

2.3 Select One Policy

The next step involves selecting a single policy from the previously defined set. The selection is guided by the following criteria: (a) the legislation must address significant aspects of Québec's health system, (b) it must be in force at the time of the study, and (c) it must be publicly accessible through an official source.

The methodological steps outlined in this research can be executed either manually or with varying degrees of automation. Given the exploratory nature of the study and the constraints imposed by academic timelines, a manual approach was adopted. This choice enabled the collection of a small yet highly relevant sample of legislation, consisting of two legislative instruments, namely a primary law and a supplementary regulation. These instruments were used to verify the proposed hypotheses and to address the research question in Chapters 3 and 4.

2.4 Prepare the Policy

The objective of this step is to convert the official text of a relevant piece of legislation into a structured digital format that facilitates the subsequent stages of the methodology.

First, the complete official text of each health policy is retrieved from reliable sources, such as government websites and official publications. In Appendix I, for example, readers will find a sample of an original policy document (Chapter A-2.2 Act to Promote Access to Family Medicine and Specialized Medicine Services), which is also available on the Légis Québec website (Québec, 2025a). This document serves as the foundation for the first case study presented in Chapter 3.

The full text is then organized in a single-column spreadsheet, with each paragraph placed in a separate cell. A thorough review is conducted to distinguish purely informational content from text with regulatory significance, retaining only the latter for further processing. For instance, excerpts such as “DIVISION III TRANSITIONAL AND FINAL. O.C. 800-2024, Div. III.” and “REFERENCES O.C. 800-2024, 2024 G.O. 2, 1722” are formally part of the legislation but provide no added value to users seeking compliance-related guidance and are therefore excluded from analysis.

The next step is to identify long paragraphs that contain multiple distinct ideas or topics. These paragraphs are divided into separate cells to improve clarity and organization. In this segmentation process, care is taken to preserve the completeness of each paragraph, ensuring it includes a subject, verb, and object. In some cases, certain elements may be duplicated or made explicit, marked with square brackets “[...]” to ensure traceability.

For instance, consider the following paragraph from the first use case:

> *23. If the president and executive director of an institution concludes that a physician failed to fulfill the obligation under section 13, he or she declares the physician to be in default. After being informed by the director of professional services or the regional department of general medicine, and if of the opinion that a physician has failed to fulfill an obligation or comply with an authorization under section 6, 7, 12, 14 or 15, the president and executive director declares the physician to be in default. Before rendering such a decision, the president and executive director must give the physician an opportunity to submit observations. The physician must submit observations within 30 days after receiving an invitation to do so from the president and executive director. The latter notifies the decision to the physician within 14 days and informs the Board.* (Québec, 2025a).

In a single, extended paragraph, the legislator combined several sentences that, although related in purpose, convey distinct ideas. The first step in processing such content is to separate these sentences, placing each one in an individual cell, as illustrated in Table 2.1.

Table 2.1 Example of text segmentation from a single paragraph of legislation used for the first use case
Adapted from Québec, A-2.2 - Act to promote access to family medicine and specialized medicine services (2025)

#	**Separate excerpt**
1	*"23. If the president and executive director of an institution concludes that a physician failed to fulfill the obligation under section 13, he or she declares the physician to be in default".*
2	*"After being informed by the director of professional services or the regional department of general medicine, and if of the opinion that a physician has failed to fulfill an obligation or comply with an authorization under section 6, 7, 12, 14 or 15, the president and executive director declares the physician to be in default"*
3	*"Before rendering such a decision, the president and executive director must give the physician an opportunity to submit observations. "*
4	*"The physician must submit observations within 30 days after receiving an invitation to do so from the president and executive director."*
5	*"The latter notifies the decision to the physician within 14 days."*
6	*"and informs the Board"*

It should be noted that in the penultimate excerpt (number 5) taken from the original paragraph, the subject is context dependent, in this case "the latter." In the final excerpt (number 6), both the subject and the object are absent. The necessary substitutions and completions are applied as shown in Table 2.2. Throughout this process, the integrity of the subject–verb–object (SVO) structure must be preserved.

Table 2.2 Example of text segmentation from a single paragraph of legislation excerpt complemented with subject and object
Adapted from Québec, A-2.2 - Act to promote access to family medicine and specialized medicine services (2025)

#	**Separate excerpt**
5	***[the president and executive director]*** *"notifies the decision to the physician within 14 days."*
6	***[the president and executive director]*** *"informs the Board"* ***[about the decision]***

By the end of this step, each cell should contain a single, clearly defined central idea, with all syntactic elements explicitly stated. Appendix II presents additional examples of excerpts prepared in accordance with the criteria established for the first case study.

2.5 Classify the Elements

This step consists of identifying the fundamental elements within the structured text produced in the previous section and rewriting them in a concise, systematically categorized format. This process is intended to facilitate the definition of metrics in the subsequent stage. The accuracy and consistency achieved at this point are decisive for the quality and reliability of the method's final output.

Basic Variables

The four basic variables used to classify the excerpts, as presented in Table 2.3, are grounded in the subject–verb–object (SVO) logic and in the "policy triangle framework," a model widely applied in health policy analysis (Walt & Gilson, 1994) that encompasses the concepts of context, process, content, and actors.

Table 2.3 Basic variables for classifying legislative expressions according to CODEM

Variable	Meaning	Examples
Actor	Equivalent to the subject It must always be made explicit	"Physician", "Government", "Supplier"
Sphere	Equivalent to the Governance levels	"Federal", "Provincial", "Municipal"
Action	Equivalent to the combination of a verb and a noun each a single word to form a complete meaning	"Send Information", "Set Role", "Set Rule", "Receive Information"
Object	Equivalent to the object of the SVO. It is recommended to keep it short (up to four words maximum if possible).	"Define publication content limits", "Contest decision"

The “actor” variable refers to the subject of the expression, typically the entity responsible for carrying out the tasks. Actors are generally identified by their functional role, expressed in one or two words at most. Proper names should be avoided unless their inclusion is essential for the intended use. Increasing the granularity of actor classification raises the operational complexity of monitoring in multi-task scenarios. When it is necessary to specify individual actors, the additional detail may be included as a second word, for example, provider physician or provider leadership.

The “sphere” variable designates the level of governance to which the subject belongs. In most cases, this is inferred from the context of the text. The most common spheres across health systems are federal, provincial, and municipal, corresponding to the typical levels of political organization of governments and, consequently, to their associated processes and governance structures.

The “action” variable is usually expressed in two words, the first being a verb and the second a noun. Actions should preferably be standardized to facilitate reuse. In the example presented in Table 2.3, “set role” and “send information” are two actions carried out for performer and receiver. These correspond to roles assigned to actors, which are explained in the following sections.

The “object” variable specifies the content of the action that the actor is expected to perform. Given their highly specific nature, objects are not usually standardized, but they should be concise, ideally limited to three or four words. Examples include “define physician replacement obligation” or “replace physician”.

The combination of action and object constitutes the “task,” which is the primary element of interest in the analysis. Each row of the classification sheet can typically generate two tasks, one for the performer and one for the receiver. However, in certain cases it is not meaningful to define a task for the receiver. For example, the statement “the expression *president* and *executive director* also means the *executive director* of a private institution under agreement”

describes a situation in which the provincial government establishes a definition for a specific actor within the context of the legislation. In this case, no additional task needs to be assigned to the actor, and only one task is generated.

Complementary Variables

In addition to the basic variables presented in the previous table, the legislative expressions are also classified according to the complementary variables shown in Table 2.4. This stage of classification requires contextual interpretation, which is currently carried out manually and relies on a subjective assessment based on a careful reading of the text.

Table 2.4 Complementary variables for classifying legislative expressions according to CODEM

Variable	Meaning	Examples
Topic	Legislation sections or topics	"Service Access", "Medical Obligations"
Task Type	Represents the strategic relevance of the task within a governance context.	"Strategic", "Tactical", "Operational"
Practical Use	Indicates the anticipated value of the task from the perspective of the receiver.	"Active", "Passive", "Operational"

Policies are often subdivided into well-defined sections or topics. The variable "topic" enables aggregation based on this logic, if needed, during information analysis, although it is not directly required in the classification process.

The "task type" variable follows a logic based on the perceived governance level and can be classified as operational, tactical, or strategic.

Operational tasks are found in declarative sentences that convey information in a direct manner, with the objective of communicating a specific and clear action, often accompanied by parameters of time, quantity, or place. For example, "The regional department or the president and executive director must respond to every application within 15 days of receiving

it" (Québec, 2025a) denotes a clear operational action to be carried out by leaders. Operational tasks are generally easier to quantify in the form of indicators.

Tactical tasks tend to be more abstract, outlining broad obligations or providing general guidance rather than prescribing specific actions. For example, "the Government may, by regulation, prescribe the periods, measures or any other parameter used to verify fulfillment of any of a physician's obligations" (Québec, 2025a). This clause underscores the government's discretionary power to define measures, timelines, and criteria for actors with operational responsibilities, without specifying their exact form or application. Tactical considerations are typically addressed by managers and coordinators, who interpret strategic goals and translate them into concrete operational directives. Tactical tasks often present greater challenges in quantification, yet they remain measurable through carefully selected indicators.

Strategic tasks present broad objectives with minimal detail, reflecting senior leaders' priorities and requiring decomposition into tactical and operational actions to achieve concrete results. For example, "the purpose of this act is to optimize the utilization of the medical and financial resources of the health system with a view to improving access to family medicine and specialized medicine services" (Québec, 2025a) represents a strategic task: a high-level policy aim that does not specify which actors, locations, or processes will bring it about. It is unlikely that a single indicator could adequately measure compliance with a strategic task.

The variable "practical use" represents a subjective interpretation of the task from the perspective of the actor and allows for three possible classifications: active, passive, and informative.

An active task implies an expectation of proactive action by the actor. For example, "The regional department informs the Régie de l'assurance maladie du Québec (the Board) of the exemption" (Québec, 2025a) is an active task defined by the provincial government for one of its representatives (the RAMQ), which must be routinely tracked and carried out by that representative.

A passive, or reactive, task depends on the occurrence of an event beyond the actor's control, which serves as a trigger for subsequent action. Conditional expressions such as "if," "upon receipt," "whenever," "when," or "may" often signal tasks of this nature. For example, "a physician who believes he or she has been wronged by a decision rendered under the first or second paragraph of section 16 or under section 18 ***may***, within 60 days of notification of the decision, contest it before the Administrative Tribunal of Québec" (Québec, 2025a). In this case, the physician can only act after receiving an unfavorable ruling from the government, an event that may or may not occur. From the physician's perspective, this is a passive task, as it depends on a prior trigger. Compliance indicators for this type of task must be calculated using variable denominators tied to the occurrence of such events, which may be null or of low frequency.

An informative task is intended primarily to provide awareness to the receiver and does not necessarily require any action by the actors involved. For example, "the institutions referred to in Schedule I are not subject to this Act" (Québec, 2025a) is informative in nature. Even for the institutions to which it applies, the expected action is simply to take note. Such tasks are not suitable for compliance measurement.

Structural Variable

One variable has a distinct function and special usage in CODEM, which is why it was intentionally kept separate in Table 2.5 for didactic purposes.

Table 2.5 Special variables Actor Role, used for classifying legislative expressions according to CODEM

Variable	Meaning	Examples
Actor Role	Defines the actor's role within the isolated expression of the except of policy.	"Definer", "Performer", "Receiver"

The “definer,” “performer,” and “receiver” categories represent roles played by actors within the legislation analyzed. Each paragraph usually contains one performer and one receiver, although the latter may sometimes be absent.

The **definer** is an actor who is seldom mentioned explicitly yet plays a crucial role in determining the actions to be carried out by others. This role is typically assumed by the legislator. For example, in the legislation that forms the basis of the first case study (Chapter 3), the definer is the provincial government of Québec, which sets the rules for other actors throughout the text. In the second case study, a specific branch of the government also acts as the definer by establishing the indicators described, through the Québec Ministry of Health. In most cases, a single definer is responsible for shaping the entire policy under analysis, although some documents may involve multiple definers. While this category is not directly used in the classification process, it serves to distinguish between the actor who assigns responsibilities and those who carry them out, thereby reducing ambiguity during classification.

The **performer** is the actor directly responsible for carrying out the initial action, while the **receiver** is the actor expected to respond to that action, typically through a subsequent task. Consider, for example, the following provision: “All general practitioners must, before ceasing to provide medical care to a patient, take the necessary steps to ensure that another physician takes over as provided for in the Code of ethics of physicians” (Québec, 2025a). The first actor is a general practitioner who, upon a trigger (before stopping care for a patient), must actively perform an action (“take the necessary steps”) directed toward a second actor (“another physician”). This second actor, in turn, must reactively carry out a follow-up action (“take over the treatment”). In this example, the general practitioner is the performer, responsible for initiating the prescribed action, and the second physician is the receiver, tasked with responding to the performer’s action and initiating their own.

Classification matrix

From a usage perspective, the basic variables presented in Table 2.3 and the complementary variables shown in Table 2.4 are applied to classify all expressions extracted from the legislation. The structural variable actor role, described in Table 2.5, is used to distinguish expressions within the same cell, as illustrated in Table 2.6. The five variables in question (actor, action, object, task type, and practical use) apply exclusively to expressions involving performers and receivers and are not used for the definer. The topic variable serves a purely informative function, with potential application for aggregating results during analysis.

Table 2.6 General Structure of CODEM Variable Usage

Meaning	**Column Header**
Topic	Topic Name
Definer	Actor
Performer	Actor
	Sphere
	Action
	Object
	Task Type
	Practical Use
Receiver	Actor
	Sphere
	Action
	Object
	Task Type
	Practical Use

Returning to the previous example, the expression "*All general practitioners must, before ceasing to provide medical care to a patient, take the necessary steps to ensure that another physician takes over as provided for in the Code of Ethics of Physicians*" (Québec, 2025b) would be classified according to the criteria described above, with the resulting coding presented in Table 2.7.

The example expression was divided into two distinct sentences, each defining a task for two actors of the same type, namely local physicians within the health system. The first actor is the performer of the action, while the second is the receiver. The government, in its role as

legislator and definer of obligations, is merely referenced, as it does not directly participate in either of the two defined tasks (Québec, 2025a).

Table 2.7 Illustrative Classification of a Legislative Expression Using CODEM

Meaning	**Column Header**	**Original Text**	**Classification Text**
Topic	Topic Name	Physicians' Obligations	N/A
Definer	Actor	Quebec Government	N/A
Performer	Actor	All general practitioners	Provider's Physician
	Sphere	Not informed	Local
	Action	Take the necessary steps	Perform task
	Object	ensure that another physician takes over	Find Substitute Physician
	Task Type	N/A	Operational
	Practical Use	N/A	Active
Receiver	Actor	another physician	Provider's Physician
	Sphere	Not informed	Local
	Action	*takes over*	Perform task
	Object	*medical care to a patient*	Assume patient care
	Task Type	N/A	Operational
	Practical Use	N/A	Passive

This classification process, previously described and exemplified, is applied to all classifiable expressions within the legislation under analysis (Section 2.3), resulting in a unique classification matrix for each policy, as illustrated in Appendix III. The same procedure is then extended to all other relevant pieces of legislation

Packaging

Every classification entails a degree of simplification, which inevitably results in some loss of information. For this reason, it is essential to maintain the link between the classification sequence and the original paragraph of the legislation. Preserving this connection is also valuable for future revisions, should the original paragraph be modified. In this context, packaging refers to the process of safeguarding this association between the classification and the original version, while also enabling subsequent version control.

Use of the Classification matrix

We identified two main ways to use the classification matrix. The first consists of "stacking" the different performer and receiver tasks into a single consolidated task list, which can then be filtered according to another variable of interest. This approach, for example, makes it possible to isolate all active operational tasks assigned to local physicians (Table 2.8), thereby paving the way for the development of compliance indicators and the creation of digital artifacts designed to support this target group.

Table 2.8 Example of Task Classification Assigned to Local Physicians

Actor + Sphere	Action	Object
Provider's Physician, Local	Perform task	Apply for obligation exemption
		Comply authorized medical activities
		Comply medical care model
		Comply minimum number hours

The second approach applies the "actor role" variable to map the direction and flow of actions from the performer to the receiver. In this method, tasks remain distinct and are not aggregated, as illustrated in Table 2.9. Each triad is composed of Actor (performer), Action (performed), and Actor (receiver), and is recorded and counted individually. This representation is particularly valuable for identifying dominant tasks and for visualizing process flows, as further demonstrated in Chapter 3.

Table 2.9 Example of Use of Mapped Elements in the Triad Logic

Actor 1 (Performer)	Action 1	Actor 2 (Receiver)
Provincial Government	Set role	[to] Provincial Government
Local Provider Physician	Send Information	[to] Provincial Government
Provincial Government	Send Information	[to] Local Provider Physician

2.6 Define Metrics

This step consists of defining indicators based on the available data sources. In the healthcare field, compliance metrics are well established in the literature. Key indicators commonly assess documentation quality, regulatory adherence, effectiveness of training, incident management, patient satisfaction, data protection, audit alignment, vendor oversight, cultural competence, and the outcomes of inspections and regulatory review (RiddleCompliance, 2025).

In the context of this research, the primary focus was on regulatory adherence, assessed through an indicator designed with a simple and accessible calculation method. Specifically, a process-based indicator was adopted, measuring the number of compliant tasks or regulations in relation to the total identified through the research methodology (Figure 2.2).

$$\textbf{Health policy/task execution rate} = \frac{\text{Total quantifiable compliance tasks/policies completed in the same period}}{\text{Total quantifiable tasks/policies in some period}} \times 100$$

Figure 2.2 Calculation formula for a generic compliance indicator

This same indicator can be consolidated at different levels and over various time frames, depending on the focus of interest and the needs of the user. The base tasks may be aggregated either by individual actors or collectively. Likewise, results can be expressed as a percentage, reflecting the degree of adherence, or as a binary classification in which a predefined threshold determines whether a task or policy is considered compliant or noncompliant with the legislation. Depending on the level of aggregation, the indicator may be assigned a specific name or remain generic (Table 2.10).

Table 2.10 Indicators suggested for measuring the degree of compliance with health policies, according to their meaning and calculation formula

Example of Indicator	Meaning
Percentage of TASK Compliance	Measures the specific level of achievement of each mapped active or passive task
Percentage of POLICY Compliance	Measures the overall level of achievement of all tasks within the same policy
Percentage of OVERALL Compliance	Measures the overall level of achievement of a set of policies

2.7 Collect Data

This stage consists of collecting and storing user data to calculate previously defined indicators. The data to be collected consists of information that will make up the numerator and denominator. For each proposed task, the aim is to highlight the number of expected occurrences, and the number achieved. As usual, aspects related to the origin, relevance and quality of the data must be observed. The information should preferably be stored in such a way as to be able to individualize each instance, enabling future recalculation in the face of changes in the indicators. If this is not possible, it can be stored in an aggregated form. If possible, storing the variables in a healthcare interoperability standard (e.g. HL7 FHIR) as a recommended practice, as it could favors future automation of the process by coupling the transactional business systems.

In this research, the limited availability of structured, open-access health system databases in the province of Québec, along with the challenges in securing direct access to healthcare managers, imposed significant constraints on the data collection process. To address this, two approaches were used: (1) collect real consolidated indicators published by the Government of Québec (Québec, 2025d) in the second case study; (2) adopt a simulation approach using randomly generated raw data, in the first case study.

2.8 Calculate Indicators

This phase involves deriving the selected indicators from the database. Each indicator is captured in two ways: a numeric variable reflecting the percentage of compliance achieved, and a binary variable indicating whether the overall compliance threshold has been met.

Because these proposed compliance metrics are process-based and straightforward to compute, their viability depends almost entirely on data availability and quality. Ensuring that every relevant event for each monitored task is accurately recorded is both process and actor dependent. Delving into the full implications of this dependency lies beyond the scope of this study, but it remains a critical consideration for any CODEM execution.

As will be shown and discussed in the forthcoming case studies, a second set of metrics, referred to as business indicators, is drawn from secondary government data sources and therefore not calculated in CODEM. Incorporating these indicators aims to enhance the digital tools' usefulness by consolidating strategic information in one location, not to duplicate existing government datasets or dashboards

2.9 Present Information

The purpose of this last stage is to deliver relevant results to the different stakeholders involved, in a manner appropriate to the needs of each level. The goal is to promote understanding and compliance with current legislation.

Compliance governance dashboards

Compliance governance dashboards are digital artifacts that are very suitable for this type of monitoring. Their design and implementation are, however, complex due to three key challenges: determining the appropriate level of abstraction for presenting information, effectively visualizing multiple analytical perspectives, and managing the vast array of related concepts, tools, and data (Silveira et al., 2009).

The research opted to present its findings through two dashboard prototypes, designed to support the research question by assessing the feasibility of the proposed methodology (chapters 3 and 4). To maintain simplicity, both dashboards were proposed with minimal features, deliberately avoiding the complexity and range of functionalities seen in other studies works (Silveira et al., 2009). Each prototype consists of two separate screens: one offering tactical and strategic insights to assist healthcare managers in decision-making, and the other focused on operational data entry, tailored for use by healthcare and quality teams.

The platform used for development was Microsoft Power BI, chosen for its powerful features, user-friendly interface, and cost-free accessibility within defined usage limits. It accommodates diverse data inputs and usually integrates smoothly with the common market data warehouses. Additionally, its native support for HL7 FHIR via API ensures direct compatibility with this healthcare interoperability standard in future improvements. Examples of dashboard construction can be found in Chapters 3 and 4.

Defining the data model is a fundamental prerequisite for building dashboards. An illustrative representation is provided in Figure 2.3, which will be examined in the following section.

Data Model

At the core of the model (Figure 2.3) lies the “Policy” table, which is designed to represent the registered policies. It includes the fields POLICY_ID, POLICY_NAME, and POLICY_TYPE, which respectively correspond to the unique primary key for indexing, the name of the policy, and its type (e.g., Act, Action Plan, Program, Guideline, etc.). The table also contains an auto-summing variable named Policy, which simply counts the total number of indexed policies using the formula Policy = COUNT(POLICY[POLICY_NAME]). Table 2.11 illustrates an example of the content found in the policy table.

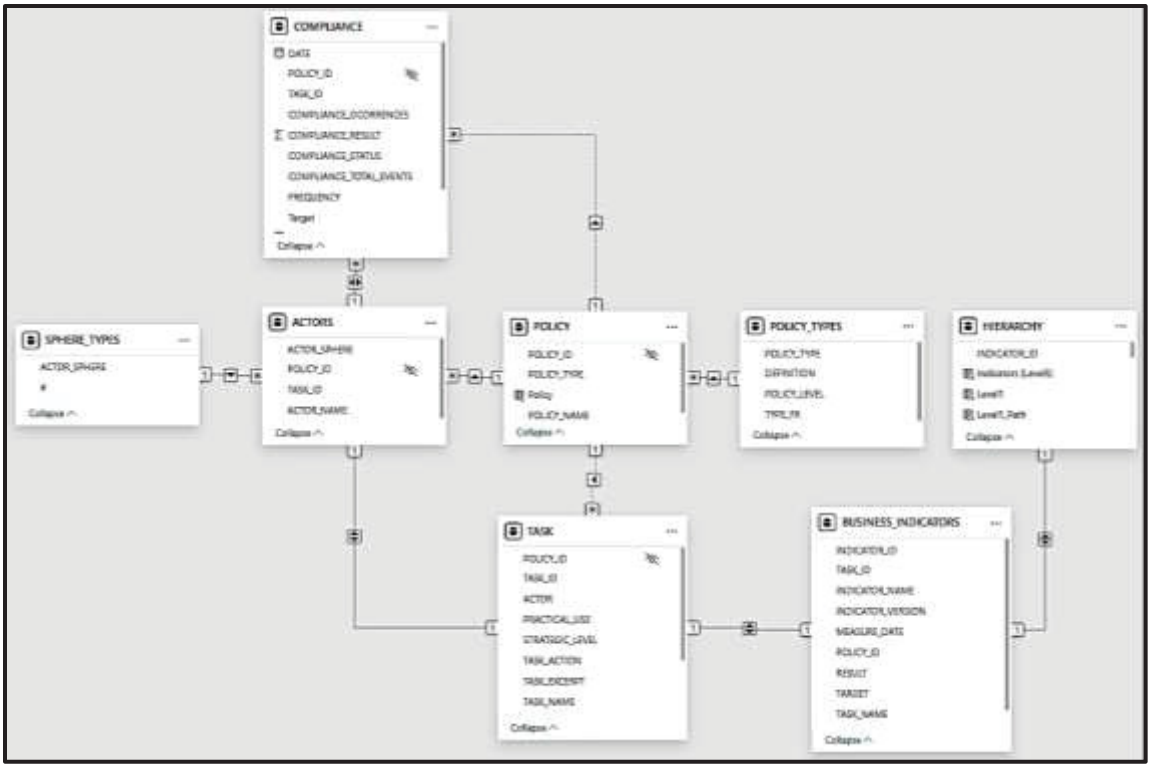

Figure 2.3 Data model in Power-BI

Table 2.11 Example Content for the Policy Table

POLICY_ID	POLICY_NAME	POLICY_TYPE	Policy
chapter_A-2.2	Chapter A-2.2 - Act to promote access to family medicine and specialized medicine services	Act	21
Chapter A-29	Chapter A-29 - Health Insurance Act	Act	21
Chapter A-29.01	Chapter A-29.01 - Act respecting prescription drug insurance	Act	21
Chapter S-2.2	Chapter S-2.2 Public Health Act	Act	21
Chapter S-4.2	Chapter S-4.2 Act respecting health services and social services	Act	21
Chapter S-5	Chapter S-5 Act respecting health services and social services for Cree Native persons	Act	21
Chapter R-5	Chapter R-5 Act respecting the Régie de l'assurance maladie du Québec	Act	21
Chapter M-19.2	Chapter M-19.2 Act respecting the Ministère de la Santé et des Services sociaux	Act	21
Chapter I-13.1.1	Chapter I-13.1.1 Act respecting Institut national de santé publique du Québec	Act	21
Chapter L-0.2	Chapter L-0.2 Act respecting medical laboratories and organ and tissue conservation	Act	21
Chapter P-42	Chapter P-42 Animal Health Protection Act	Act	21
Chapter J-3	Chapter J-3 Act respecting administrative justice	Act	21
Chapter A-5.01	Chapter A-5.01 Act respecting clinical and research activities relating to assisted procreation	Act	21
Constituition	Constitution Act, 1867	CON	21
CQLR_A-6.01	Public Administration Act (CQLR, c. A-6.01)	Act	21
CQLR_M-19.2	Act respecting the Ministère de la Santé et des Services sociaux (CQLR, c. M-19.2)	Act	21
MSSS_SP_2327	2023–2027 QUEBEC MSSS ACTION PLAN	Action Plan	21
MSSS_OTHER	Other Regulations under the Act respecting the Ministère de la Santé et des Services sociaux	OTHER	21
Chapter G-1.021	Chapter G-1.021 Act respecting the governance of the health and social services system	Act	21
SANTE_AP	Three-Year Strategic Plan under the Act respecting the governance of the health and social services system	Action Plan	21
SANTE_OTHER	Other Regulations under the Act respecting the governance of the health and social services system	OTHER	21

The variable POLICY_TYPE maintains a one-to-many (1: N) relationship with a table of the same name, from which it draws its data. This table contains the fields POLICY_TYPE, TYPE_FR, DEFINITION, and POLICY_LEVEL. The possible types of registered legislation are listed in the first two fields, the first in English and the second in French, along with their standardized definitions provided in the third field. The last field aims to define the hierarchical level at which the policy is situated, in accordance with the levels described in the Table 1.1. The lowest hierarchical level corresponds to the value 0, which represents a draft law (Bill), and the numbering increases for higher levels, with the highest values associated with subordinate legislation. Equal values indicate equivalent levels, as can be seen in the Table 2.12.

Table 2.12 Example Content for the Policy Type Table

POLICY_TYPE	TYPE_FR	DEFINITION	POLICY_LEVEL
Bill	Projet de loi	Legislative text proposed to the National Assembly	0
Act	Loi	Law adopted by the National Assembly	1
Statute	Loi / Texte législatif	May be synonymous with "Act" depending on the legal context	1
Regulation	Règlement	Rule that implements a law, usually approved by decree	2
Decree	Décret	Government order approving regulations or administrative measures	2
Order in Council	Arrêté en conseil	Formal decision taken by the Executive Council	2
Ministerial Order	Arrêté ministériel	Order issued by a Minister	2
Administrative Order	Ordonnance administrative	Administrative decision with regulatory force	2
Program	Programme	Set of government policies or actions	2
Action Plan	Plan d'action	Strategic document with concrete measures	2
Strategie	Stratégie	Long-term vision outlining goals and priorities	2
Norm	Norme	Technical or regulatory standard, often set through regulation	2

The ACTOR table is also related to the POLICY table through POLICY_ID in a one-to-many (1: N) relationship. It contains the fields ACTOR_NAME, ACTOR_SPHERE, POLICY_ID, and TASK_ID, which respectively indicate the actors involved, their spheres of influence, and which actors are linked to each policy and each task. In addition to indexing the possible actors, it helps manage the coupling between actors, spheres, policies, and tasks. This structure was chosen to simplify the manual tests. However, in a more complex scenario with greater diversity and content volume, it is ideally recommended that this coupling be managed in a dedicated table. An example of the content of this table can be seen in the Table 2.13.

Table 2.13 Example Content for the Actor Table

POLICY_ID	TASK_ID	ACTOR_NAME	ACTOR_SPHERE
chapter_A-2.2	ACT_chapter_A-2.2_088	Government	Provincial
chapter_A-2.2	ACT_chapter_A-2.2_087	Government	Provincial
chapter_A-2.2	ACT_chapter_A-2.2_094	Government	Provincial
chapter_A-2.2	ACT_chapter_A-2.2_002	Supplier	Any level
chapter_A-2.2	ACT_chapter_A-2.2_001	Supplier	Any level
chapter_A-2.2	ACT_chapter_A-2.2_143	Undefined Actor	Any level
chapter_A-2.2	ACT_chapter_A-2.2_144	Undefined Actor	Any level
chapter_A-2.2	ACT_chapter_A-2.2_025	Provider Physician	Local
chapter_A-2.2	ACT_chapter_A-2.2_018	Provider Physician	Local

The TASK table is another central table in the model. As its name suggests, it stores information related to tasks classified by CODEM. As in previous cases, TASK_ID is the primary index. POLICY_ID and ACTOR_ID are related to their respective tables, in (N:1) and (1:1) relationships, respectively. The fields _ACTOR, _ACTION, _OBJECT, STRATEGIC_LEVEL, and PRACTICAL_USE store content of their respective types, while TASK_EXCERPT holds the full content of the original paragraph. Finally, calculated variables are included: Practical_Use (= COUNT(TASK[PRACTICAL_USE]), Strategic_Level (= COUNT(TASK[STRATEGIC_LEVEL]), and Task_number (= COUNT(TASK[TASK_ID]), which contribute to the statistical counts displayed on the dashboard. An example of the content of these variables can be seen in table 2.14.

Table 2.14 Example Content for the Task Table

POLICY_	TASK_ID	TASK_NAME	TASK_ACT	TASK_OBJECT	STRATEGI	PRAC	TASK_EXCERPT	ACTOR
chapter_A-2.2	ACT_chapter_A-	Perform task | Publish ser	Perform task	Publish service ind	Operational	Active	The Government may als	Provincial Government
chapter_A-2.2	ACT_chapter_A-	Perform task | Publish ser	Perform task	Publish service ind	Operational	Active	prescribe the requireme	Provincial Government
chapter_A-2.2	ACT_chapter_A-	Perform task | Publish ser	Perform task	Publish service ind	Operational	Active	11.1. To allow for the bo	Provincial Government
chapter_A-2.2	ACT_chapter_A-	Perform task | Recovers co	Perform task	Recovers compens	Operational	Active	Such a physician must ol	Provincial Government
chapter_A-2.2	ACT_chapter_A-	Perform task | Recovers co	Perform task	Recovers compens	Operational	Active	13. Every medical specia	Provincial Government
chapter_A-2.2	ACT_chapter_A-	Perform task | Reduce phy	Perform task	Reduce physician r	Operational	Active	In connection with his or	Provincial Government
chapter_A-2.2	ACT_chapter_A-	Perform task | Review exe	Perform task	Review exemption	Operational	Active	14. Every medical specia	Provincial Government
chapter_A-2.2	ACT_chapter_A-	Perform task | Review Wo	Perform task	Review Workload E	Tactical	Active	15. Every medical specia	Provincial Government
chapter_A-2.2	ACT_chapter_A-	Perform task | Revise Wor	Perform task	Revise Workload E	Operational	Active	15. Every medical specia	Provincial Government

The HIERARCHY data table contains the fields indicated in the Table 2.15. Its purpose is to enable the functionality of displaying different health policies in a hierarchical format, including graphical representation, as demonstrated in Chapter 4. To achieve this, it uses s DAX coding in Power BI, as exemplified in the Algorithm 2.1. The code presented in this and the following algorithm tables was developed with assistance from MS Copilot.

Table 2.15 Hierarchy table variables in the Power-BI model

VARIABLE	EXPLANATION	DATA EXAMPLE
INDICATOR_ID	Unique key for each indicator	MSSS_23
POLICY_NAME	Descriptive name of the health policy related to the indicator	INDICATOR - 23. Average length of stay on stretcher
POLICY_ID	Unique key for each registered health policy	Policy_1234
POLICY_ID_PARENT	Points to the related POLICY_ID at the immediately higher level	MSSS_AP
Level1	Name of the highest-level legislation in the hierarchy. In the example, the Canadian Constitution was used	Constitution Act
Level2	High-level legislation. In the example, the Public Administration Act	Public Administration Act (CQLR, c. A-6.01)
Level3	Intermediate-level legislation. In the example, the MSSS institution	Act respecting the Ministère de la Santé et des Services sociaux (CQLR, c. M-19.2)
Level4	Name of the lowest-level legislation in the hierarchy. In the example, the action plan detailing the indicators of interest was used	MSSS ACTION PLAN 2023–2027
Level5	List of business indicators considered	INDICATOR - 23. Average length of stay on stretcher
Level1_Path	Maps the full path of level 1 legislation. Internal variable	CONST
Level2_Path	Maps the full path of level 2 legislation. Internal variable	A601
Level3_Path	Maps the full path of level 3 legislation. Internal variable	M19-2
Level4_Path	Maps the full path of level 4 legislation. Internal variable	MSSS_AP
Level5_Path	Maps the full path of level 5 legislation. Internal variable	MSSS_23
PolicyPath	Indicates the hierarchical structure of the current element.	CONST|A601|M19-2|MSSS_AP|MSSS_23

Algorithm 2.1 Hierarchy DAX Code

VARIABLE	DAX CODE EXAMPLE
Level 1 Path (similar for levels 2-5)	Level1_Path = PATHITEM('HIERARCHY'[PolicyPath], 1, TEXT)
Policy Path	PolicyPath = PATH('HIERARCHY'[POLICY_ID], 'HIERARCHY'[POLICY_ID_PARENT])
Level1 name (similar for levels 2-5)	Level1 = LOOKUPVALUE('HIERARCHY'[POLICY_NAME], // Column with the name to return 'HIERARCHY'[POLICY_ID], // Column where the criteria is searched [Level1_Path] // Value of the ID at level 1 (created by PATHITEM))

The SPHERE_TYPES table simply indexes the different levels of governance, as showed in Table 2.16.

Table 2.16 Sphere Types Table in the Power-BI model

ACTOR_SPHERE	#
Any level	0
Federal	1
Provincial	2
Local	3

The BUSINESS_INDICATORS table is where external data related to business indicators is stored. INDICATOR_ID, _NAME, _VERSION, and MEASURE_DATE are identifiers for these indicators, while RESULT and TARGET hold results and goals. TASK_ID links to the corresponding table, allowing external indicators to be precisely attached to the part of the legislation that addresses them. Finally, the % TARGET measure (= PRODUCT (BUSINESS_INDICATORS[TARGET]) *100) expresses the goals as percentages. A sample of the table's content can be found in the Table 2.17.

Table 2.17 Business Indicator Table Content Example

POLICY_ID	TASK_ID	TASK_NAME	INDICAT	INDICATOR_NAME	IND	MEASURE_DAT	RESUI	TARGE
MSSS_SP_2327	AP_MSSS_SP_2327_017	Set TASK | Calculate periodic indicator	MSSS_01	INDICATOR - 01. 0-12 month	V1	2023	71,3	72,2
MSSS_SP_2327	AP_MSSS_SP_2327_084	Set TASK | Calculate periodic indicator	MSSS_02	INDICATOR - 02. Percentage	V1	2023	999	999
MSSS_SP_2327	AP_MSSS_SP_2327_132	Set TASK | Calculate periodic indicator	MSSS_03	INDICATOR - 03. Employee e	V1	2023	84	85
MSSS_SP_2327	AP_MSSS_SP_2327_139	Set TASK | Calculate periodic indicator	MSSS_04	INDICATOR - 04. Number of	V1	2023	15,9	19,6
MSSS_SP_2327	AP_MSSS_SP_2327_146	Set TASK | Calculate periodic indicator	MSSS_05	INDICATOR - 05. Percentage	V1	2023	87	100
MSSS_SP_2327	AP_MSSS_SP_2327_181	Set TASK | Calculate periodic indicator	MSSS_06	INDICATOR - 06. . Percentag	V1	2023	999	80
MSSS_SP_2327	AP_MSSS_SP_2327_153	Set TASK | Calculate periodic indicator	MSSS_07	INDICATOR - 07. Proportion	V1	2023	13,3	11,5
MSSS_SP_2327	AP_MSSS_SP_2327_182	Set TASK | Calculate periodic indicator	MSSS_08	INDICATOR - 08. Percentage	V1	2023	999	30
MSSS_SP_2327	AP_MSSS_SP_2327_166	Set TASK | Calculate periodic indicator	MSSS_09	INDICATOR - 09. Proportion	V1	2023	64	60
MSSS_SP_2327	AP_MSSS_SP_2327_024	Set TASK | Calculate periodic indicator	MSSS_10	INDICATOR - 10. Age-standa	V1	2023	221,4	214,758
MSSS_SP_2327	AP_MSSS_SP_2327_031	Set TASK | Calculate periodic indicator	MSSS_11	INDICATOR - 11. Coverage r	V1	2023	31,6	38
MSSS_SP_2327	AP_MSSS_SP_2327_180	Set TASK | Calculate periodic indicator	MSSS_12	INDICATOR - 12. Percentage	V1	2023	53,6	65
MSSS_SP_2327	AP_MSSS_SP_2327_039	Set TASK | Calculate periodic indicator	MSSS_13	INDICATOR - 13. Number of	V1	2023	6950	8668
MSSS_SP_2327	AP_MSSS_SP_2327_046	Set TASK | Calculate periodic indicator	MSSS_14	INDICATOR - 14. Percentage	V1	2023	50	50

Finally, the COMPLIANCE table is responsible for storing relevant data used in the dynamic calculation of the previously described compliance indicators, according to the selected grouping (Table 2.18). The identification fields are POLICY_ID and TASK_ID, which allow the results to be linked to the corresponding section of the legislation. COMPLIANCE_TOTAL_EVENTS represents the denominator of the task of interest, based on the validity period defined by the DATE variable. Meanwhile, COMPLIANCE_OCORRENCES corresponds to the numerator, that is, the number of instances in which the task reached the compliance level indicated by TARGET. The COMPLIANCE_RESULT field stores the outcome of the calculation, and COMPLIANCE_STATUS holds the final interpretation of the result compared to the specific target. The FREQUENCY variable indicates when DATE becomes obsolete, requiring a new measurement.

Table 2.18 Compliance Table Content Example

POLICY_ID	TASK_ID	COMPI	COMPL	COM	Targ	COMPLIANCE_	FREQUENCY
MSSS_SP_2327	AP_MSSS_SP_2327_004	18	65	27,6923(	71	Non-Compliant	ANNUAL
MSSS_SP_2327	AP_MSSS_SP_2327_014	12	30	40	85	Non-Compliant	ANNUAL
MSSS_SP_2327	AP_MSSS_SP_2327_017	1	12	8,33333	71	Non-Compliant	ANNUAL
MSSS_SP_2327	AP_MSSS_SP_2327_020	9	35	25,7142	80	Non-Compliant	ANNUAL
MSSS_SP_2327	AP_MSSS_SP_2327_021	18	64	28,125	65	Non-Compliant	ANNUAL
MSSS_SP_2327	AP_MSSS_SP_2327_023	22	74	29,7297	75	Non-Compliant	ANNUAL
MSSS_SP_2327	AP_MSSS_SP_2327_033	29	99	29,2929	81	Non-Compliant	ANNUAL

Lastly, three measures are added: COMPLIANCE_EVENTS (=SUM(COMPLIANCE [COMPLIANCE_OCORRENCES])) which totals the number of occurrences within each grouping, and COMPLIANCE_LEVEL, responsible for dynamically calculating the compliance indicator for groupings that depend on user selection, whose calculation formula can be seen in Algorithm 2.2.

Algorithm 2.2 DAX Code for the COMPLIANCE_LEVEL Variable

```
Compliance Level =
DIVIDE(
   SUM(COMPLIANCE[COMPLIANCE_OCORRENCES]),
   SUM(COMPLIANCE[COMPLIANCE_TOTAL_EVENTS]),
   9999)
```

In Chapters 3 and 4, we will demonstrate the application of this methodology through two case studies. The first concerns an active law in Quebec, titled “Chapter A-2.2 – Act to promote access to family medicine and specialized medicine services”. The second relates to a supplementary piece of legislation: an action plan developed by the “Ministère de la Santé et des Services Sociaux (MSSS) of the Government of Quebec”.

CHAPTER 3

CASE STUDY OF AN ACT

This chapter tests the methodology described in Chapter 2 within the context of an active health policy formally enacted as law (Act) in Québec (Figure 3.1). Its objective is to contribute to answering the research question and to generate lessons learned for broader application in the development of software engineering artifacts aimed at supporting health policy management in Québec.

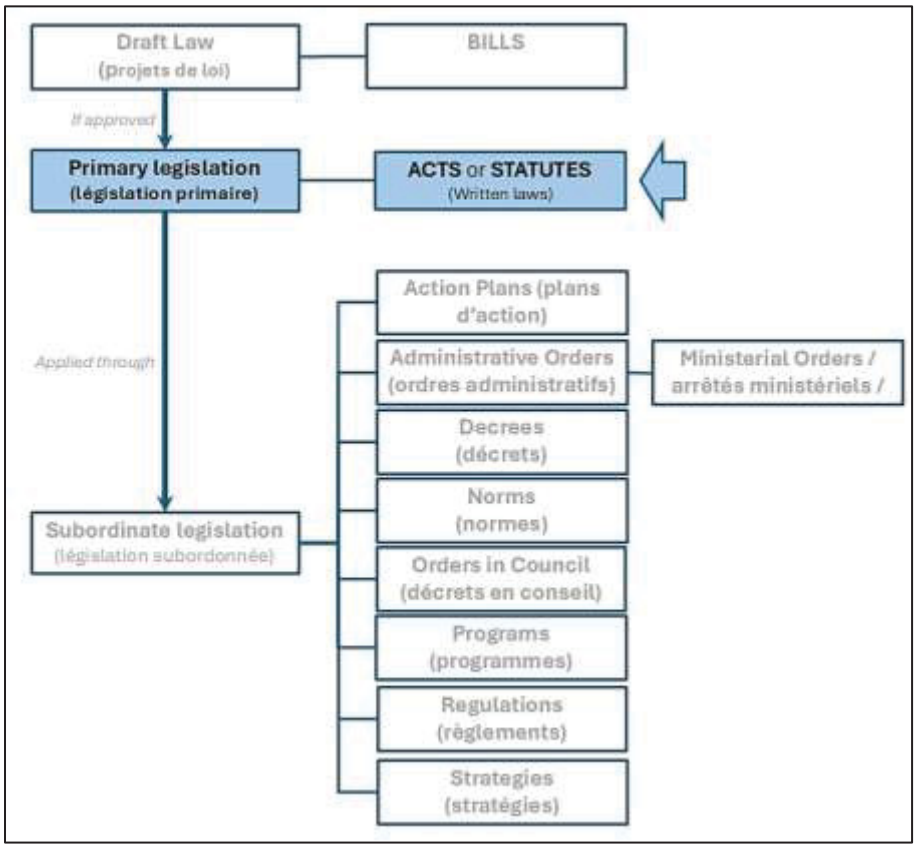

Figure 3.1 Classification of Québec legislation, highlighting the hierarchical position of the health policy analyzed in the first case study

3.1 Identify Policies

The set of health policies that serves as the starting point for this study consists exclusively of active Acts in Québec, as identified through official provincial sources (Légis Québec, 2025). Supplementary legislation, Bills, federal legislation and policies from other provinces that may apply to or have relevance to Québec were also excluded from the analysis.

3.2 Select One Policy

The “Chapter A-2.2 – Act to promote access to family medicine and specialized medicine services” is an official and primary piece of legislation originally enacted in December 2015. The version available at the time of this analysis was that of December 2024, but its most recent update occurred on March 24, 2025 (Québec, 2025a) . This Act is comprehensive and well-developed, having been in force for nine years, during which it has undergone multiple amendments and revisions. It comprises 21,359 words and 1,080 paragraphs, including 282 legal clauses. Due to its active status, scope, and maturity within Québec’s legislative framework, it was selected as the first use case.

3.3 Format the Policy

The formatting of the original policy (Appendix I) generated 132 classifiable excerpts, after the process of isolating informative excerpts and unfolding long paragraphs or paragraphs with multiple ideas (Appendix II).

3.4 Classify the Elements

The classification process of the 132 excerpts , with selected examples shown in Appendix III. It allowed the identification of actors and their respective spheres, as well as their tasks, consisting of actions and objects, later interpreted in terms of the strategic and practical usefulness of the information. The entire process of manual formatting and classification of this specific standard required between 10 and 14 hours, distributed across three complete

cycles of iterative review. The main challenge consisted in maintaining consistency of CODEM criteria across all expressions, thereby reducing intra-observer variability throughout the different iterations

Five distinct actors were identified (Table 3.1). In approximately 90% of cases, tasks were concentrated on the provincial government and local provider physicians. Local provider leadership (that is, the managers of the health services themselves) appeared as actors in only about 8% of cases. For two tasks, no clear actor could be defined (approximately 1%). Overall, the provincial government emerged as the primary performer (79%) and the second-biggest receiver (41%). The local provider physician was the major receiver (44%).

Table 3.1 The actors identified through the decomposition of the analyzed legislation

Actor	Sphere	Tasks from Performer		Tasks from Receiver		Total Tasks	
		Number	%	Number	%	Number	%
Supplier	Any	0	0%	2	2%	2	0,9%
Provider Leadership	Local	9	7%	9	10%	18	8,1%
Provider Physician	Local	19	14%	40	44%	59	26,6%
Government	Provincial	104	79%	37	41%	141	63,5%
General Public	Any	0	0%	2	2%	2	0,9%
Valid records		132	100%	90	100%	222	100,0%

Table 3.2 shows actions classified. Overall, seven actions, from three distinct categories, were sufficient to characterize all the legislation analyzed. The most frequent tasks were “perform task” (28.8%), “set rule” (21.6%), “set role” (15.3%) and “send information” (13.5%), together accounting for 79.2% of the cases. The main role of the performer was “set rule” (36.4%) and of the receiver was “perform task” (48.9%).

The task analysis (Table 3.3 and Table 3.4). reveals significant diversity in both task types (Appendix IV) and practical applications (Appendix V). Although the high level of granularity complicates generalization by means of consolidation, the classification process demonstrated that most tasks are active (55%) and operational (67%).

Table 3.2 The actions identified through the decomposition of the analyzed legislation

Category	Action	Tasks from Performer		Tasks from Receiver		Total Tasks	
		Number	%	Number	%	Number	%
Type of Task	Perform task	20	15,2%	44	48,9%	64	28,8%
Regulation	Receive Regulation	0	0,0%	16	17,8%	16	7,2%
	Set Role	34	25,8%	0	0,0%	34	15,3%
	Set Rule	48	36,4%	0	0,0%	48	21,6%
Information	Request Information	2	1,5%	0	0,0%	2	0,9%
	Send Information	28	21,2%	2	2,2%	30	13,5%
	Receive information	0	0,0%	28	31,1%	28	12,6%
Total		132	100%	90	100%	222	100%

Table 3.3 Consolidated Tasks by Type

Status	Tasks	%
Active	144	55%
Informative	64	24%
Passive	32	12%
n/a	24	9%
Total	264	100%

Table 3.4 Tasks consolidated according to practical use

Status	Tasks	%
Operational	178	67%
Tactical	54	20%
n/a	24	9%
Strategic	8	3%
Total	264	100%

The general logic observed in this type of legislation involves a performer initiating an action directed toward a receiver, which may or may not include an additional action. Considering these three points of interaction (performer > action > receiver), the legislation can be represented according to the flow established in Table 3.5. Notably, the entire policy comprises

28 distinct interactions, with 10 accounting for more than 80% of all tasks. Among these, five interactions alone represent approximately 54% of the total tasks. Additionally, about 14% of tasks had no associated receiver.

Table 3.5 Interaction Between Provider and Receiver

Vector (Provider + Action + Receiver)	Tasks	%	% cum
Provincial Government | Set Role | Local Provider Physician	19	14,4%	14,4%
Provincial Government | Set Rule | N/A	18	13,6%	28,0%
Provincial Government | Set rule | Provincial Government	15	11,4%	39,4%
Provincial Government | Set Rule | Local Provider Physician	10	7,6%	47,0%
Provincial Government | Set role | Provincial Government	9	6,8%	53,8%
Local Provider Physician | Send Information | Provincial Government	8	6,1%	59,8%
Provincial Government | Send Information | Local Provider Physician	8	6,1%	65,9%
Local Provider Physician | Perform task | Provincial Government	7	5,3%	71,2%
Provincial Government | Perform task | Provincial Government	7	5,3%	76,5%
Provincial Government | Send Information | Provincial Government	7	5,3%	81,8%
Other Relations	24	18,2%	100%
Total	132	100,0%	100%

A more intuitive way to visualize these flows is through a Sankey diagram (Figure 3.2), which is widely supported in tools such as Power BI and other interactive dashboards. The figure presents a graphical representation of Table 3.5, excluding the 24 less significant relationships, allowing for a clearer and more focused view of the main flux.

The Sankey diagram visually reinforces these dynamics. It clearly shows that most tasks originate from the Provincial Government (90%), with flows concentrated in the definition of rules (54%) and roles (33%). These tasks are primarily directed toward the Provincial Government itself and physicians practicing in the province. Physicians, in turn, account for approximately 10% of the tasks, all related to the transmission of information back to the Provincial Government. Notably, 22.8% of the government's tasks are aimed at establishing internal rules for the healthcare system, without being assigned to any specific actor. The diagram effectively highlights the asymmetry in task distribution and the central role of the Provincial Government in shaping the system's operational framework. It is interesting to note

how CODEM enables the conversion of an entire health policy into a graphical representation of its internal building blocks.

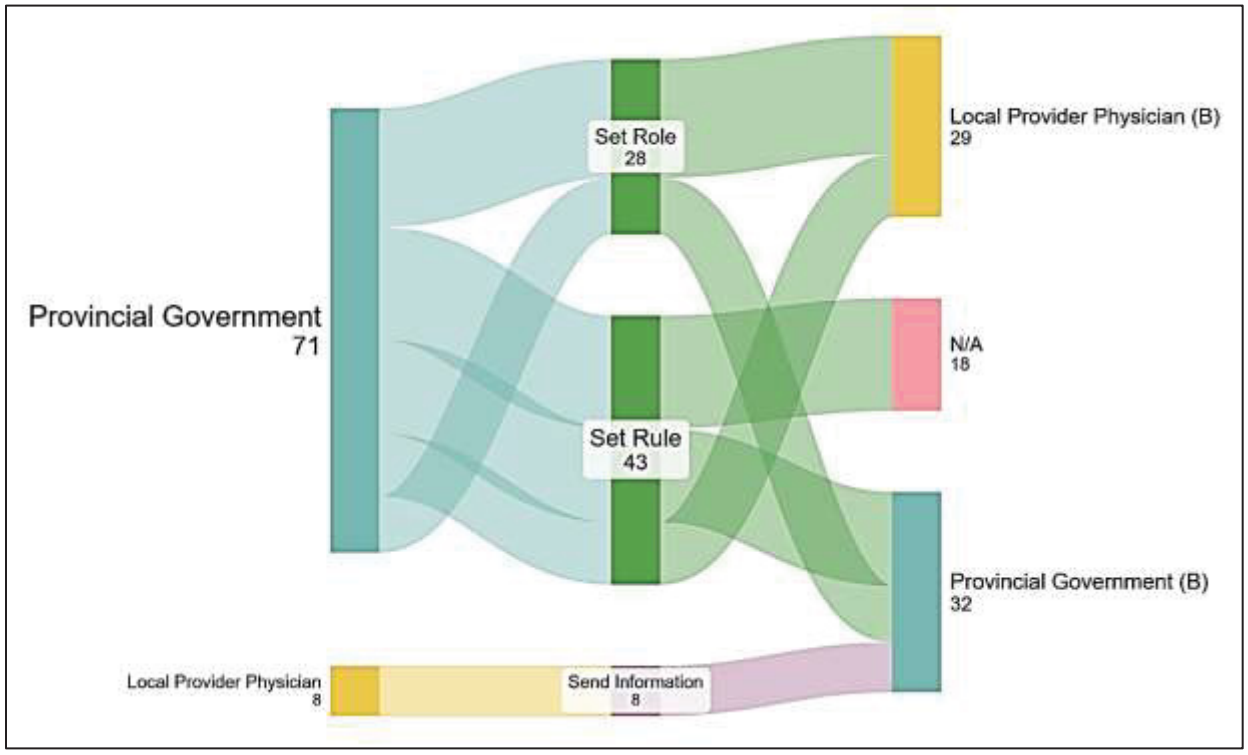

Figure 3.2 Sankey Diagram of the Interactions Mapped by CODEM Between Performers and Receivers, based on the Number of Tasks
Taken from the Model Available for Steve Bogart at Sankeymatic.com (2025)

3.5 Define Metrics

In selecting quantifiable tasks, only those classified as active under the "practical utility" variable were considered, as "passive tasks" tend to be unpredictable and "informative tasks" typically do not require immediate action. This process resulted in the identification of 144 quantifiable tasks, organized as shown in Table 3.6. Most of these were either directly assigned to the provincial government (56%) or involved performing a task (61%).

Table 3.6 Number of quantifiable tasks by actor, for compliance indicator purposes

Task	Tasks by Actor					Total	
	Supplier	Local Provider Leadership	Local Provider Physician	Provincial Government	General Public	Num	Per %
Perform task	2	9	35	42		88	61,1%
Send Information		2	10	16	2	30	20,8%
Set Role				15		15	10,4%
Set Rule		2		5		7	4,9%
Request Information		1		1		2	1,4%
Receive information				1		1	0,7%
Set task				1		1	0,7%
Total Geral	**2**	**14**	**45**	**81**	**2**	**144**	100,0%

Each actor was assigned a package of indicators (table 3.6) with one individual indicator for each task and a general compliance indicator by the entire set of assigned tasks. All indicators were calculated based on the formula presented in chapter 2 (figure 2.2).

Considering that each task can occur in multiple instances, the unit indicators were expressed as a percentage, representing the ratio between the number of completed instances (numerator) and the number of predicted instances (denominator).

The general indicator was obtained by the sum of the tasks for numerators divided by the sum of the tasks for denominators of all individual indicators belonging to each group, also expressed as a percentage. This general indicator was calculated separately for each actor and solely, considering all tasks.

For a didactic reason, each task indicator received a nomenclature consisting of an abbreviation of the responsible actor and a sequential number (table 3.7). But in practice, it is the same indicator, just under different aggregations and filters.

Table 3.7 Meaning and utility of indicators of first case study

Code	Name	Utility
PL	*Local provider leadership*	Actor and task specific indicator
PP	*Local provider physician*	
PG	*Provincial government*	
AS	*Any level supplier*	
UA	*General Public*	
GAC	*General actor compliance*	All valid tasks consolidated, by actor.
OPC	*Overall policy compliance*	All valid tasks consolidated, regardless of the actor.

3.6 Collect Data

As highlighted in chapter 2, due to the limited availability of open-access health system databases in the province of Québec and direct access to healthcare managers, a simulation approach using randomly generated raw data was adopted in the first case study. An electronic spreadsheet was developed containing the list of indicators, each labeled according to the classification rule detailed in section 3.6 (Appendix VI). Two columns were then added to generate arbitrary and random numbers between 0 and 100, employing the formula "=RANDBETWEEN(0,100)". The numbers produced in the initial iteration were fixed in two additional columns, from which the highest and lowest values were assigned respectively as the denominator and numerator.

3.7 Calculate Indicators

This step involves calculating the selected indicators from the available information in the database.

Subsequently, the percentage value for each indicator was calculated. An optional target classification column was created, based on an arbitrarily defined cutoff point set at 80%. Results equal to or above this threshold were classified as compliant (value 1), while those below were considered non-compliant (value 0). The results are presented in Appendix VII.

Finally, global indicators were computed by actor and overall, as shown in Table 3.8. All 131 classifiable excerpts were fully translated into complete classification expressions.

Table 3.8 Results of global indicators

Indicator	Tasks	Numerator	Denominator	Total
AS-GAC	2	78	154	50,6%
PL-GAC	14	443	925	47,9%
PP-GAC	45	1281	2849	45,0%
PG-GAC	81	2544	5488	46,4%
UA-GAC	2	47	128	36,7%
OPC	144	4393	9544	46,0%

3.8 Present Information

The final step involves making the information available for users in a simple and clear way

The dashboard featured in this case study serves as a tool for evaluation and visualization, illustrating the outcomes of the proposed method. Its purpose is to demonstrate and assess the effectiveness of the methodology for decomposing and classifying health policies, providing valuable input for the development of technological artifacts in software engineering. It is important to note, however, that the dashboard itself does not constitute an academic contribution to the research. To assist in modeling the case study dashboard, we used the persona framework (Pruitt & Grudin, 2003) to created a hypothetical healthcare manager in Quebec as follow:

Lucien Moreau is a 51-year-old health administrator at Montreal's DRSP (Direction Régionale de Santé Publique), with a master's in public health and over two decades of hands-on experience in public health operations. Under a mandate from the Quebec Ministry of Health, he is responsible for assessing compliance across five distinct CIUSSS (Centres Intégrés Universitaires de Santé et de Services Sociaux) as part of a province-wide healthcare reform

initiative. He routinely consults management dashboards and possesses deep knowledge of service workflows. His primary challenge lies in navigating a fragmented health information system landscape, while his greatest frustration stems from low stakeholder engagement in matters of legal and procedural compliance.

Using the example of Lucien Moreau, we developed the user scenario bellow. In it, the manager interacts with the prototyped dashboard to illustrate this first case study (Figure 3.3), initially analyzing a situation, formulating key questions, and using the regulatory dashboard to explore possible answers.

To fulfill his mission, Lucien defined key questions that guided his analysis: (1) How many and which health policies are currently in effect? (2) What is our overall compliance rate with these policies? (3) How is compliance distributed by policy? (4) How is compliance distributed by stakeholders? (5) Which ones apply to each stakeholder in his business? (6) Which policies and tasks require the most attention?

Upon accessing the management dashboard, Lucien noted its division into four quadrants with distinct purposes (Figure 3.4): policy information (A), selection filters (C), actor data (B), and task-related details (D). He immediately identified 15 active health policies relevant to his organization (A2), viewable through the interface (A4, C3), thereby answering his first question regarding how many and which policies were currently in effect. Adjacent to the policy count was a graphical gauge displaying a general compliance rate of 50.1% for these policies (A1), addressing his second inquiry.

By selecting a specific policy (C3), the compliance gauge dynamically adjusted based on the combination chosen. Each policy’s individual compliance could also be examined (A4), along with the number of events considered in its calculation (A3), resolving his third question. Further down, the dashboard displayed a list of involved actors and their respective compliance rates (B), which answered his fourth question. Interestingly, selecting an actor (B) updated the list of applicable policies for that individual (A4), thus answering his fifth question.

Crucially, Lucien observed numerous tasks tied to legislation and specific actors (D2), some with notably low compliance (D1). He could inspect task details, expected actions per actor (D1, D3), and sort tasks by strategic relevance and type (D4). Ultimately, he discovered that the greatest compliance gap resides from unfulfilled administrative obligations of clinical physicians in the evaluated units, his final key concern. This insight prompted him to schedule a meeting with CIUSSS managers to discuss strategies for improving adherence to these responsibilities.

The dashboard illustrating Lucien's use case was developed as a functional prototype in Power BI. The first step in its construction was the definition of the data model, shown in Figure 2.3. This model guided the creation of Excel tables containing sample data and variables, which were imported and processed by establishing relationships between the variables. Next, calculation metrics were established as measures using the logic presented in the previous section. Lastly, the layout was structured, and the dashboard was published online.

It should be emphasized that the dashboard does not constitute a contribution of this research but rather serves to illustrate the feasibility and practical utility of the proposed method.

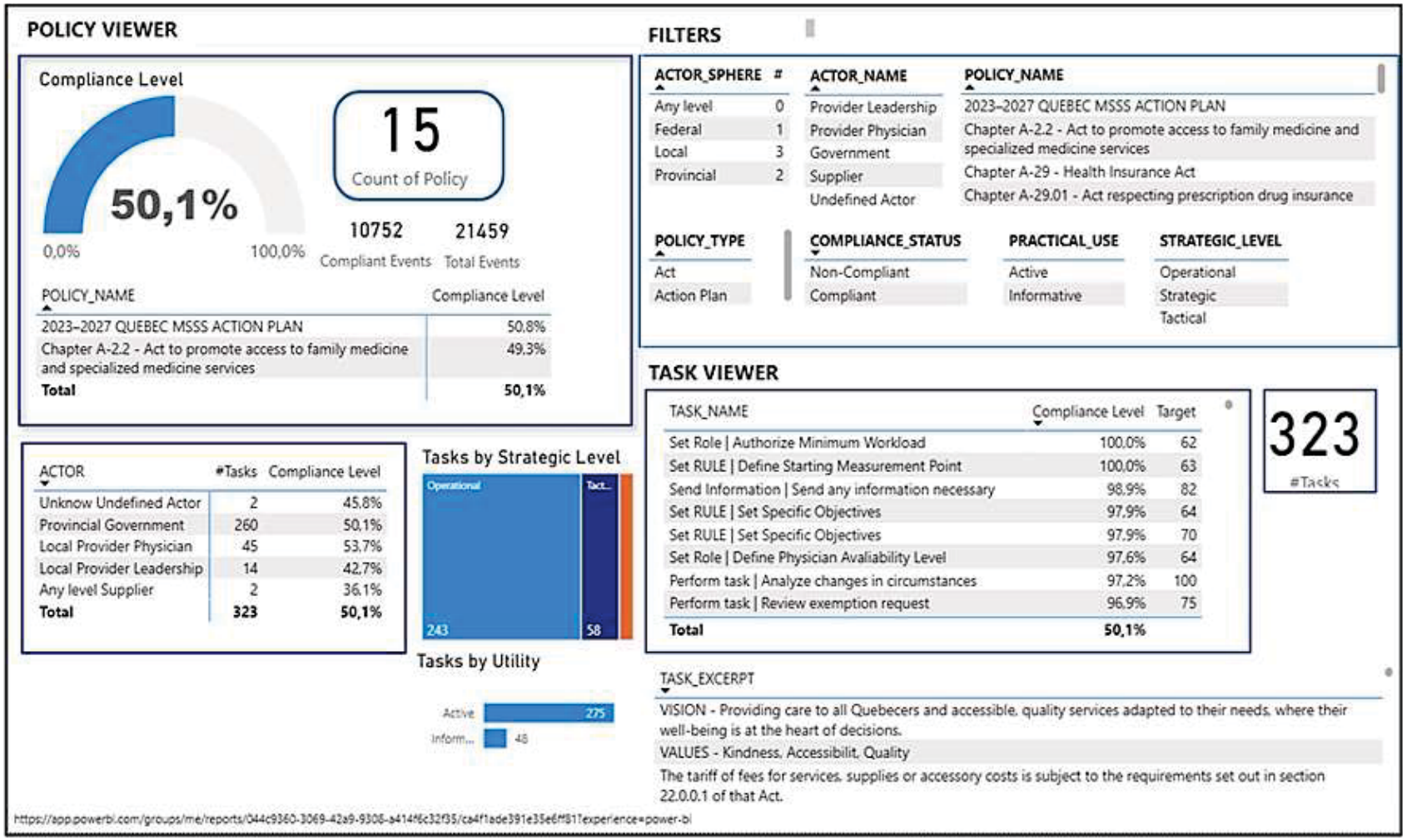

Figure 3.3 Functional prototype of the management dashboard

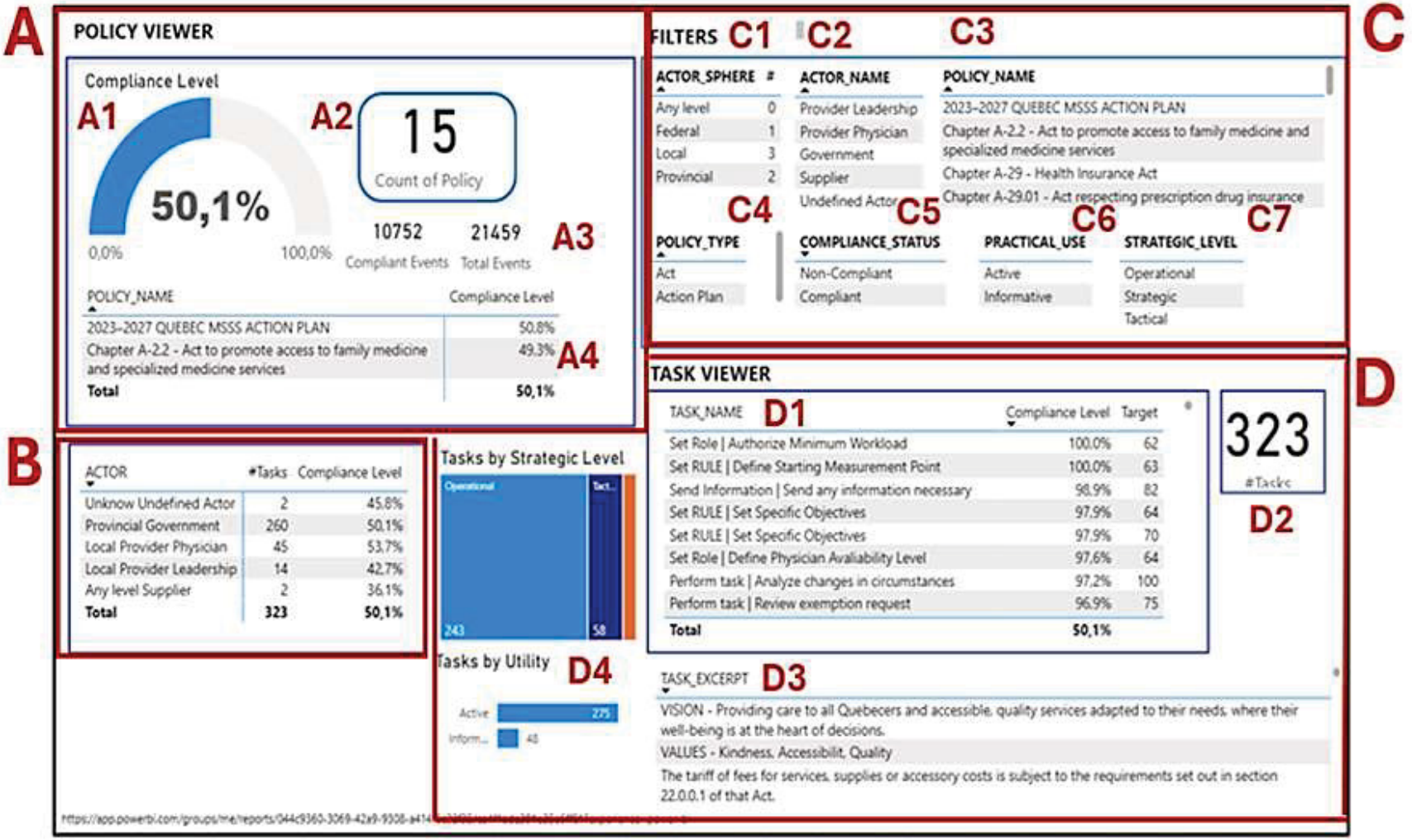

Figure 3.4 Management Dashboard Quadrants

CHAPTER 4

CASE STUDY OF AN ACTION PLAN

This chapter applies the methodology presented in Chapter 2 to an example of health legislation that directly addresses the measurement and evaluation of health system performance in Québec. Its objective is to assess how the method operates with real-world data instead of simulated results and, where relevant, to examine its applicability to subordinate legislation, with a lower level of abstraction.

4.1 Identify Policies

The set of health policies that serves as the starting point for this study consists of active primary and secondary legislation of Québec, identified through official platforms (Légis Québec, 2025), websites (Québec, 2025c) and reports (Québec, 2023b). Bills, federal legislation and policies from other provinces that may apply to Québec were excluded from the analysis.

4.2 Select One Policy

The initial target is to identify legislation that explicitly references health system performance metrics. Analysis using the resources outlined in section 4.1 revealed that legislative Acts usually do not mention specific indicators or metrics. Instead, they tend to emphasize the importance of assessment, define institutional roles, and identify the actors involved, often delegating the specification of metrics to those actors or to subordinate legislative instruments, as action plans.

This approach may reflect the inherent dynamism of performance indicators, which require frequent updates to remain effective in system evaluation. Including them in highly abstract legislation could potentially impede their flexibility over time. This possibility may have

influenced the government's decision to incorporate such indicators into supplementary legislation, where revisions can be made more responsively.

In fact, such detail can be seen in action plans and websites produced by the Québec government. One example from policy G-1.021: “124. The strategic plan of Santé Québec is established according to the form and content and at the intervals determined by the Government. It must indicate, in particular, (…) the performance indicators to be used in measuring the achievement of results” (Québec, 2023a).

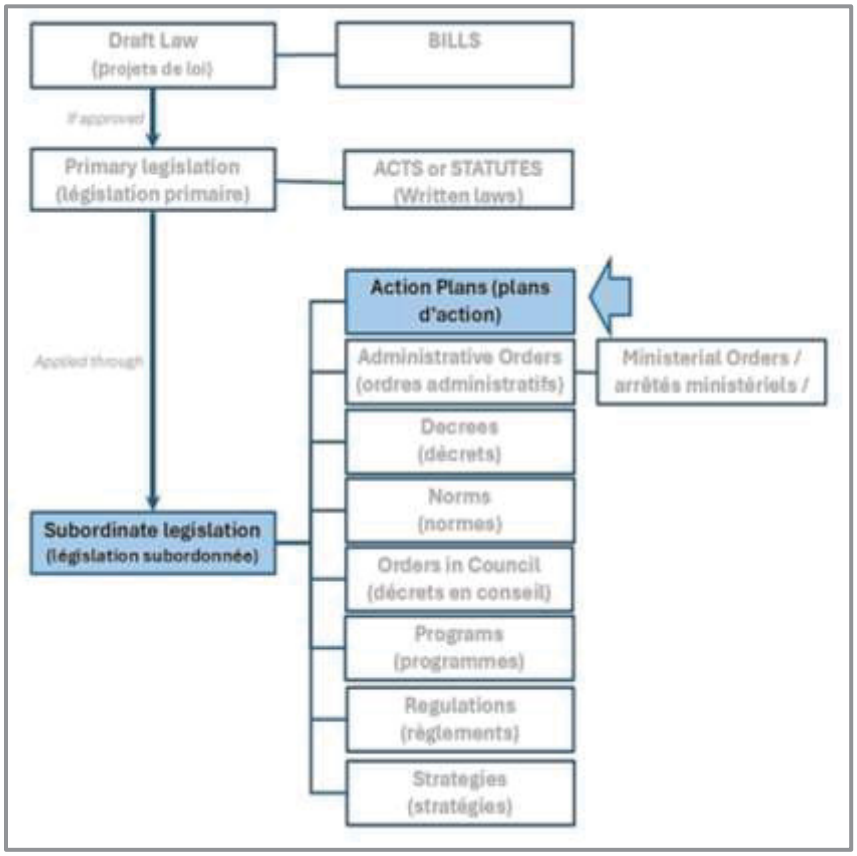

Figure 4.1 Classification of Québec legislation, highlighting the hierarchical position of the health policy analyzed in the second case study

We aimed to better understand how administrative and compliance indicators are integrated within Québec's legal framework. This required gaining insight into the hierarchical structure of health legislation in the province. Despite our efforts, we were unable to find any explicit representations of this hierarchy, including on official government websites. Consequently, we undertook the challenge of reconstructing a sample structure across various levels, shown in Figure 4.2. It should be noted that the figure represents our understanding of a fragmented process and may contain inaccuracies.

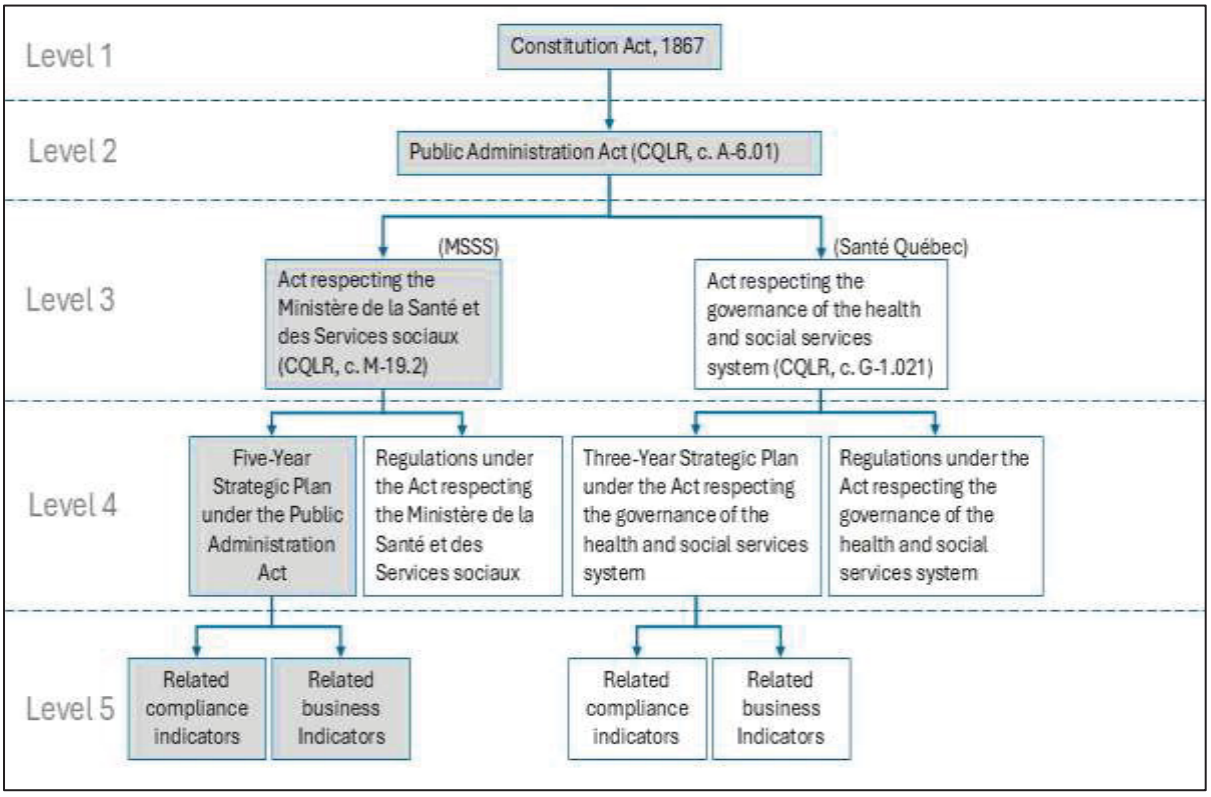

Figure 4.2 Classification of Québec legislation, highlighting the hierarchical position of the health policy analyzed in the second case study

In our reconstruction, the Québec Constitution at Level 1 serves as the foundation for a public administration act, which occupies Level 2. That act then supports two distinct legislative instruments that, through different pathways and timeframes, led to the creation of the Ministère de la Santé et des Services Sociaux (MSSS) and Santé Québec, represented at Level

3. Within the MSSS pathway, we identified several complementary regulations, including a five-year strategic plan situated at Level 4. This plan defines a series of performance indicators, referred to here as business indicators. Additionally, we introduced a corresponding group of compliance indicators at Level 5. Then, the choice of this case study was given to the 2023 to 2027 strategic plan published by the MSSS which directly addresses the business indicators.

4.3 Format the Policy

The original MSSS 36-page French report was converted into English using Google Translate. Qualitative analysis of this version showed a variable level of abstraction, combining 34 discursive pages and a two-page summary table, also offered as a stand-alone file on the government's official website. The analysis focused on this summary table (Appendix VIII). The formatting process produced 179 classifiable excerpts, 5,606 characters and 877 words. Since the original information was presented in tabular form, a systematic conversion was required: each indicator was restructured into a paragraph along with its strategic objectives and initial measures. Annual targets and comments were also converted into separate paragraphs, linked to the relevant indicator. To preserve the table's visual logic, suggesting a link between strategic objectives and indicator sets, paragraphs were generated using the indicator name followed by “[HAS GOAL]” and the respective strategic objective.

4.4 Classify the Elements

The classification of 179 excerpts (Appendix IX) was sequentially mapped to enable subsequent analysis. The process took approximately six hours, given the greater simplicity of the expressions compared to the first case study. The definer is the provincial government. The provider and receiver are not explicitly stated in this document, as the summary table omits information about the actor responsible for compiling the indicators. Table 4.1 presents the tasks classified by action type. Three fundamental categories encompass eight mapped tasks, with “define indicator target” (51.4%) and “set specific objectives” (22,3%) emerging as the

most frequent. The distribution highlights task concentration both by typology (Table 4.2) and by practical application (Table 4.3). As anticipated, operational and proactive tasks prevail.

Table 4.1 Frequency of tasks according to actions and objects, after classification of the MSSS action plan summary table

Action	Object	#	%
Set ROLE	Set General Objectives	1	0,6%
Set RULE	Achieving Specific Service Objectives	4	2,2%
	Define Indicator	1	0,6%
	Define Indicator Target	92	51,4%
	Define Starting Measurement Point	18	10,1%
	Define time for calculation	1	0,6%
	Set Specific Objectives	40	22,3%
Set TASK	Calculate periodic indicator	22	12,3%
	Total	179	100,0%

Table 4.2 Consolidated Tasks by Type

Type	#	%
Operational	134	74,9%
Strategic	20	11,2%
Tactical	25	14,0%
Total	179	100,0%

Table 4.3 Tasks consolidated according to practical use

Practical Use	#	%
Active	131	73,2%
Informative	48	26,8%
Total	179	100,0%

4.5 Define Metrics

In Chapter 3, the first case study utilizes the policy compliance indicators outlined in Section 2.6. This set of indicators is primarily designed to ensure adherence to legal requirements and to monitor task completion in accordance with relevant legislation. The second case study introduces an additional set of metrics, referred to here as business indicators, which are aimed at assessing institutional performance. These are based on standardized calculation methods and publicly defined performance targets previously established by the Québec government to evaluate the healthcare system. An organization may comply with legal processes yet fail to meet its strategic goals or achieve those goals without strict policy alignment. Both sets of indicators depend on effective database management and the transparent dissemination of results.

Although not directly related to the objective of the study, the published business indicators were retained and used in this case study, as they demonstrate the possibility of integrating external indicators into the digital artifacts created through CODEM. Furthermore, when incorporated into the hierarchical representation of existing health policies, they enable a critical analysis of their usefulness on a broader scale.

Compliance indicators were calculated as outlined in the section "Define the Metrics" of Chapter 2. Business indicators were not computed directly; instead, their results were sourced from original information repositories. The indicator known as the conversion rate of original legislative expressions was determined by dividing the number of valid paragraphs with complete coding by the total number of valid paragraphs, expressed as a percentage. The target value for this indicator was set at 90 percent or higher.

4.6 Collect Data

Compliance Indicators

As this data is frequently administered internally and not readily available to the public, the study was conducted using simulated data to enable this type of analysis.

Business Indicators

To apply business indicators effectively, it was necessary to identify where the Québec government publishes their business indicators' results. Although the MSSS action plan (Québec, 2025b) lacks specific formulas and information on data collection responsibilities, this detail can be found through further investigation using the government's website (Québec, 2025d), methodological notes (Québec, 2025) and a referenced technical document (Québec, 2020). There is also a Power BI dashboard (Québec, 2025f), called *Performance of the health and social services network*, that allows visualization of key health and social services metrics with a patient flow diagram and tabs for different service areas, including graphs (figure 4.3) and trend lines (figure 4.4). However, this dashboard does not exactly reflect the list of indicators proposed by the MSSS action plan.

Taking as example the urgence indicators for the system's performance measurement, we see that the Québec government highlighted: Average Time to Emergency Care for All Customers (*Délai moyen de prise en charge à l'urgence pour toute la clientèle*) and Average Length of Stay on Stretcher (*Durée moyenne de séjour sur civière*). Such indicators do not appear on the Dashboard home screen MSSS. However, in the tabfolder "urgence", we could find an indicator homonymous to the second one mentioned.

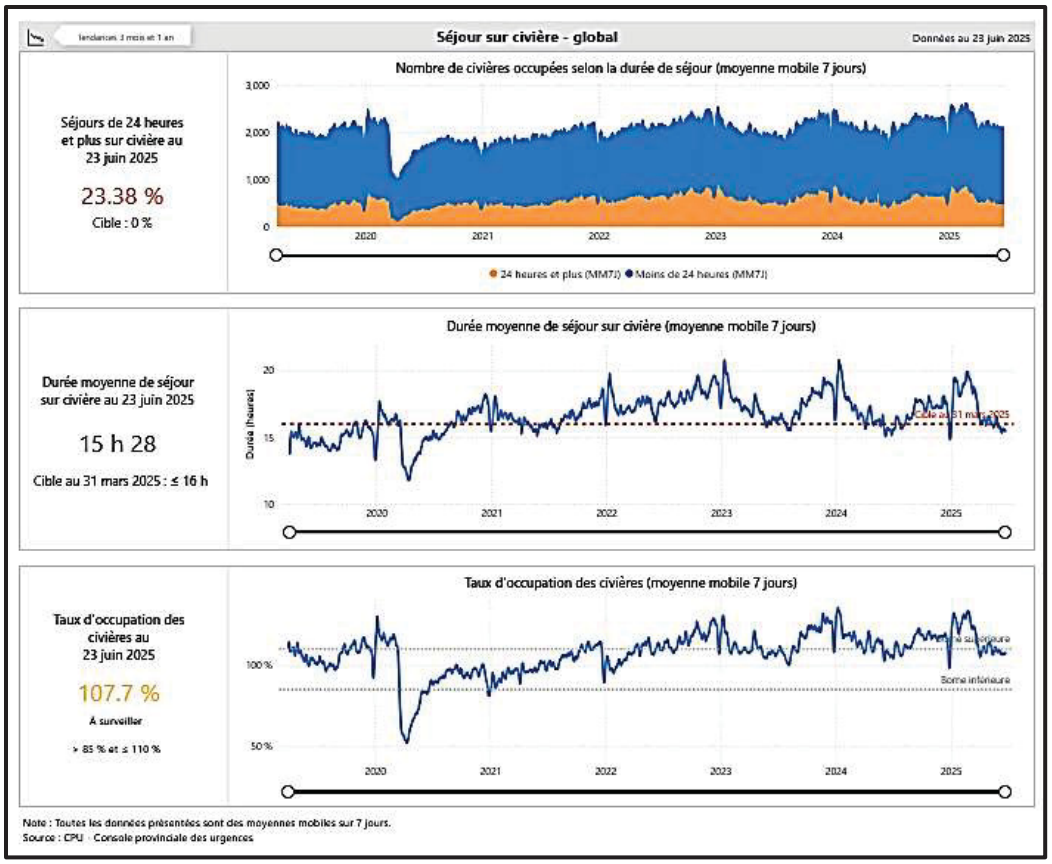

Figure 4.3 Example of graphs representing the behavior of some business indicators
Taken from Québec, MSSS - Tableau de bord – Performance du réseau de la santé et des services sociaux. (2025)

Figure 4.4 Example of representation of means and tendences of one Québec health indicator
Taken from Québec, MSSS - Tableau de bord – Performance du réseau de la santé et des services sociaux. (2025)

4.7 Calculate Indicators

This step involves calculating the selected indicators from the available information in the database. All 179 classifiable excerpts were fully translated into complete classification expressions. Relations between indicators and tactical targets were also coded as valid excerpts. The values calculated for the compliance indicators followed the same logic as in the first use case. To avoid redundant analysis, this section omits a detailed explanation and instead presents the results directly within the prototype.

It is important to note that the base document was a two-page indicator sheet rather than the full action plan, most of which was deemed descriptive and explanatory rather than regulatory and thus excluded from analysis.

4.8 Present Information

This step illustrates the practical applicability of the proposed methodology by presenting a functional prototype of a managerial dashboard developed in Power BI.

Designed to support healthcare managers in monitoring compliance with relevant legislation, the dashboard serves as a supplementary resource rather than a substitute for the official provincial health dashboards. Like the first case study, this prototype is not intended as a formal academic contribution. Instead, it functions as a means of translating the research findings into a more concrete and accessible format.

Building once again on the persona introduced in Case Study 1, we revisit Lucien Moreau, a senior manager at the DRSP. Using the dashboard presented in Section 3.8, Lucien was able to examine relationships, distribution patterns, and compliance levels with current healthcare policies across the CIUSSSs under his jurisdiction. Most importantly, the tool enabled him to pinpoint areas of non-compliance that required coordinated action between administrators and

clinical teams. However, as a manager, Lucien also needed to monitor the impact of the initiatives he implemented with the teams under his leadership. With this in mind, we developed the case study below.

Six months after the last CIUSSS strategy meeting, where actions had been agreed upon to reduce compliance gaps, Lucien was invited, alongside other high-level managers, to a strategic event focused on Quebec's new health system model. This meeting, convened by the provincial Minister of Health and attended by representatives of MSSS and Santé Québec, began with the Minister acknowledging challenges in implementing the model and the gap between legislative frameworks and practical realities.

During the presentation, the Minister revealed a dashboard interface previously unknown to Lucien, featuring a hierarchical tree (Figure 4.5) that mapped the entirety of Quebec's healthcare legislation. This dashboard was designed to answer the following key questions: (1) How do legislation and healthcare systems at different levels interact in Quebec? (2) How are business indicators related to these regulations? (3) Is there a correlation between low compliance with published indicators and poor performance in the healthcare business? (4) Who are the key stakeholders involved?

The dashboard dynamic prototype for this case study (figure 4.6) comprises visualization and selection panels: four-level hierarchical filters (A), a tree diagram (B), a business indicators panel (C), and a tasks panel (D). The first key question (how legislation interacts across levels in Quebec) is addressed by panels A and B, which navigate from general laws (B1) to specific regulations (B4) and their associated indicators (B5), thereby answering the second question. These indicators are listed in panel C1 with official results and targets (C3). Selecting an indicator displays related legislative tasks structured by the study's methodology (D1), with each task's compliance level shown (D2). Joint analysis of panels C and D addresses the third question on the potential correlation between low compliance and poor performance in business indicators. Finally, the filters in section D1 allow identification of specific stakeholders and the strategic and operational attributes of the selected tasks.

Seeing this dashboard, for the first time, Lucien Moreau was able to visually comprehend how well-known policies interconnected, translating abstract, high-level system design concepts into structured regulations, action plans, and outcome indicators. These indicators were divided into two distinct groups: one reflecting performance targets established by the Ministry within the healthcare domain, and the other focusing on the regularity and quality of data generation itself. Both sets of indicators were firmly grounded in the provisions of existing legislation.

This experience shifted Lucien's perspective. What had once appeared to be a complex and opaque system of administrative procedures was now understood as the foundational structure of a dynamic and evolving healthcare system, with the potential to benefit the broader population of Quebec. Motivated by this newfound understanding, Lucien committed to using the dashboard regularly as a strategic tool for deepening his knowledge of the reformed healthcare model.

The data model from the first case study served as the foundation for the current analysis, with the addition of two Excel-based tables titled Business Indicator and Hierarchy, both incorporated into the Power BI data model (Figure 2.3). The Hierarchy table is responsible for defining a five-level hierarchical structure and contains the variables listed in Table 2.15. The DAX code used to construct these hierarchies is reproduced in Algorithm 2.1.

The final layout was carefully structured, and the dashboard was published online. As with the first case study, it is important to highlight that the dashboard itself is not presented as a contribution of this research. Instead, it serves exclusively to illustrate the feasibility and practical applicability of the proposed method.

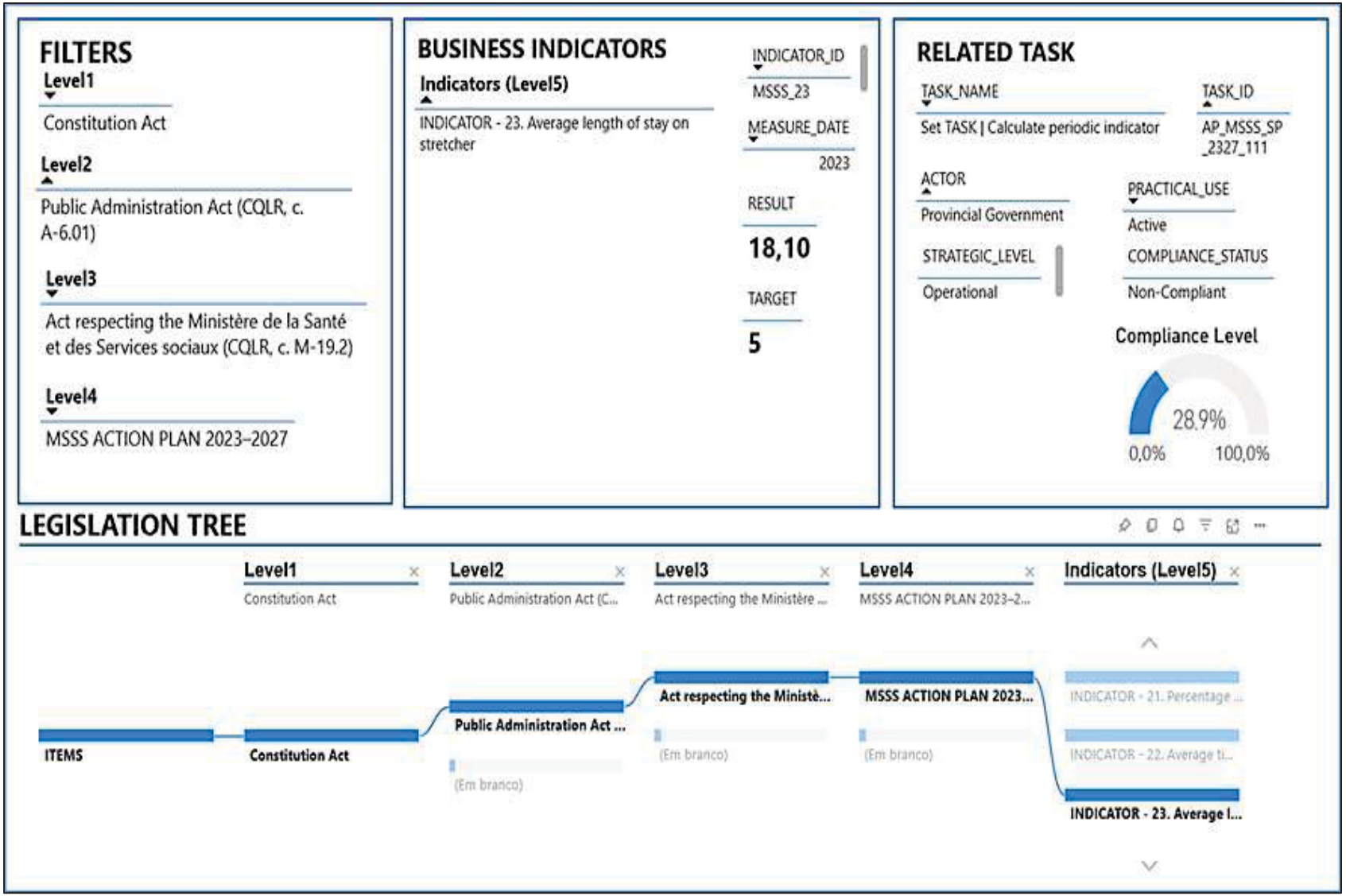

Figure 4.5 Functional prototype of the management dashboard

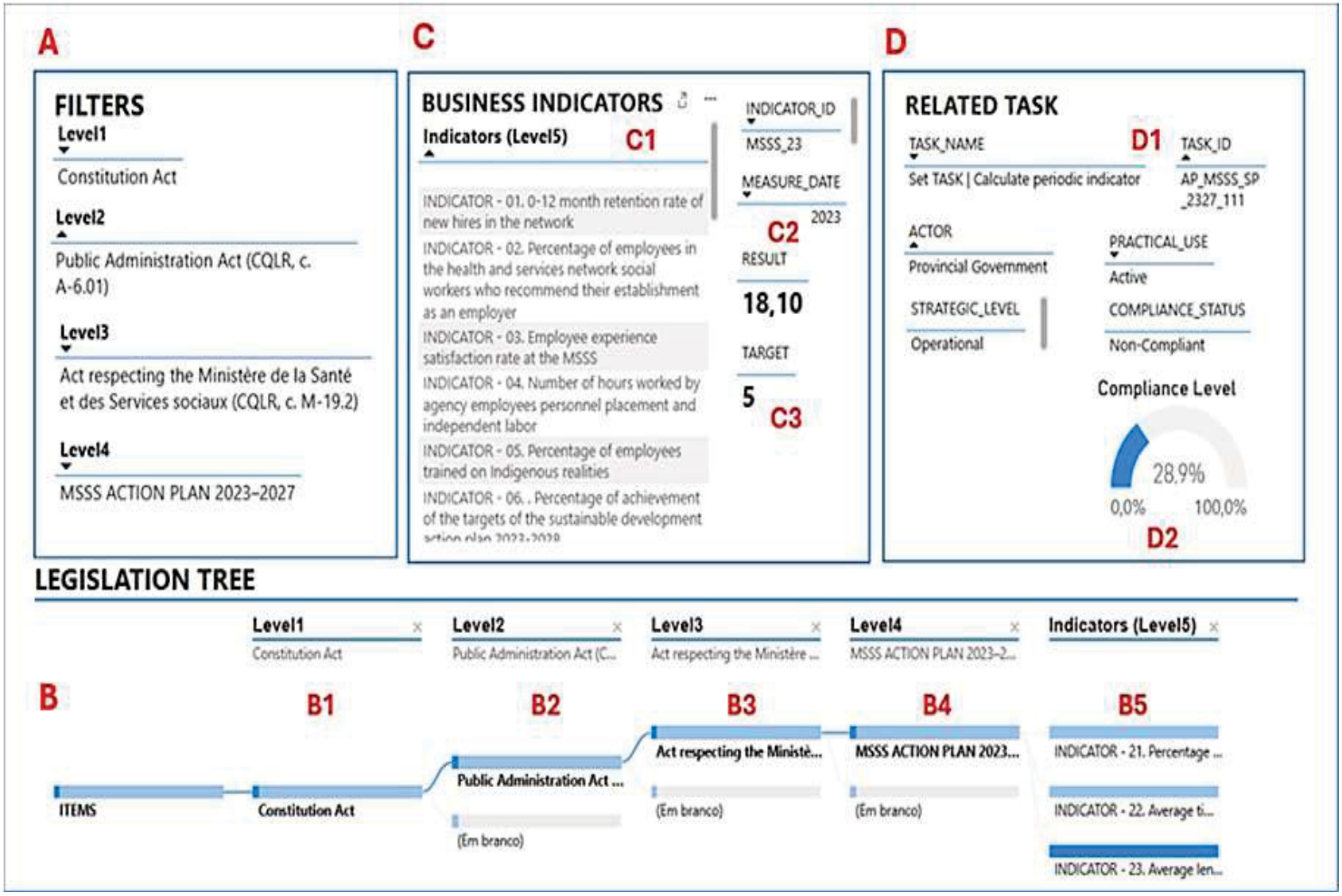

Figure 4.6 Quadrants present in the functional prototype of the management dashboard

CHAPTER 5

DISCUSSION AND EVALUATION

This chapter presents and analyzes the results, aiming to address the research question through the lens of the testable hypothesis. It then explores the study's limitations and potential threats to validity, followed by a comparative discussion with relevant literature.

5.1 Interpretation of Key Findings

In response to the research question "How can policies be incorporated into digital metrics and representations to support compliance and governance within Québec's health system", a research hypothesis was formulated. This hypothesis is broken down into two subcomponents, each of which is discussed in sequence.

SH1 - Quebec's health legislation contains core policy elements (actors, spheres, tasks) that can be systematically extracted and classified

In this study, the hypothesis proposed that core policy elements (actors, spheres, and tasks) could be extracted and/or converted into components usable for research. A qualitative examination of the sample substantiated this hypothesis. Several factors may have contributed to this outcome. First, the elimination of purely descriptive information refined the database by removing unusable content. Second, the regulatory nature of the records, rich in tasks and assignments, aligned well with the subject verb object semantic schema adopted in the study, and this structural simplicity may have further facilitated the process. Finally, the formatting stage, in which lengthy legislative paragraphs were divided into smaller fragments, also played a positive role, as multiple ideas, tasks, and assignments embedded in a single statement would otherwise have rendered the conversion process more complex and potentially flawed.

Three factors could lead to the rejection of the hypothesis. The first is that the theoretical model forming the basis of the method may lack representativeness. This concern is examined in the

section “Threats to Validity and Mitigation” later in this chapter. The second is that the conversion and coding procedures may prove inadequate. The third is that a high frequency of missing elements could compromise the overall conversion rate.

SH2 - [These core policy elements] can be encoded as metrics to support regulatory compliance and enable interactive governance dashboards.

The two case studies demonstrated the feasibility of the proposed method for metrication and representation. In both scenarios, descriptive statistics were employed to quantify the elements derived from the decomposition of legislation. Compliance levels of actors, tasks, and policies were dynamically displayed in the sample dashboards, based on the selection of filters corresponding to each component. Additionally, pre-existing business indicators and their targets, developed by the Government of Québec, were successfully encoded using the format proposed by the research method. This enabled a new application possibility by anchoring business outcomes directly to the entire legislative chain.

The process-based indicator adopted, which measures the number of compliant tasks or regulations against the total identified through the research methodology, is a relatively simple, low-complexity metric that offers advantages in implementation, comprehension, and use. It is, however, subject to arbitrary cutoff definitions by the user and only addresses key questions related to the occurrence of event instances. Despite this, we consider this type of indicator sufficient for the purposes of our research. We believe that, in the future, other classical compliance indicators can also be coded and incorporated into these strategic dashboards.

5.2 Discussion of Results

In this section, we summarize the results of the two case studies and reflect on their significance from both a business and software engineering perspective, considering the possible

implications for potential users. The limitations and strengths of the study, as well as ideas for future development, are discussed in the conclusion chapter.

Summary of Observations

The first legislation analyzed, Chapter A 2.2 Act to promote access to family medicine and specialized medicine services, addresses a highly relevant aspect of the current reality of the Quebec health system, which is access to basic health services. The statement of this policy sets out four objectives: promote access to family doctors, promote access to specialized medicine, increase the access to primary services, and improve the management of this access.

After applying CODEM, we observed that the provincial government is the main performer and the second main receiver of the regulation, behind only local physicians. This is a new finding, as it shows that the method allowed for a comprehensive quantification of each actor's participation as both origin and destination of tasks. When examining the nature of these tasks, it is possible to see that in 83.4% of cases they involve defining a role, a business rule, or an obligation to send information by the performer. From the receiver's perspective, almost half the time they are expected to perform a specific task or receive specific information or regulation. More than half of all tasks in the regulation are active and operational, followed by tasks of an informative nature and of tactical use.

The second case study focused on the application of CODEM to an indicator matrix present in an action plan issued by the MSSS, which constitutes a supplementary regulation. All indicators and goals were coded using this method. Finally, an attempt was made to create an articulated visualization of multiple regulations in the form of a hierarchical tree. The intention was to allow each indicator and supplementary regulation to be anchored in their respective high-level legislation, grouped in a way that makes logical sense to users at the moment of use. Such representation was successful in this single example.

Analysis of Results

Using (Benny Firmansyah & Arry Akhmad Arman, 2022) framework, our research work relies on the business architecture layer through the stages of collection, processing, analytics and visualization, demonstrated in the legislation decomposition method and two dashboard examples. The data architecture focuses on converting unstructured regulatory data into structured data using a decomposition and classification method. The application layer involves calculating compliance indicators and aggregating the remaining information to support decision-making. The technology layer is oriented toward service-based and web-based applications.

CODEM has the potential to enhance compliance with legislation in several ways: by enhancing clarity; by improving the efficiency of interpretation; by operationalizing tasks and metrics; by facilitating feedback; by enabling practical solutions. Based on the data from the two use cases, the following section evaluates these contributions.

(1) Enhancing clarity

In the context of this research, greater clarity refers to a more accurate and comprehensive understanding by stakeholders of the elements defined by legislators within health policy texts.

It is well recognized that high level legislation can often be generic in nature. Depending on its drafting style, such legislation may give rise to ambiguity, internal inconsistencies, or even contradictions with other legal instruments. CODEM seeks to achieve this enhanced clarity through several mechanisms: the explicit identification of the actors involved in each action; the specification of their governance spheres and roles (as definer, performer or receiver); the clarification of the corresponding tasks; the classification of these tasks by type (such as strategic, tactical or operational) and by practical use (such as informative, passive or active). Findings from the two case studies demonstrate that this process is feasible for both high level legislative instruments such as acts and lower-level supplementary regulations such as action plans.

In the first case study, CODEM was applied to generate a structured version of “Chapter A 2.2 - Act to promote access to family medicine and specialized medicine services from Quebec”. The main actors identified in this legislation were listed and quantified in table 3.1 along with their roles and task types in tables 3.2 to 3.4. The principal interaction flows emerged from the application of the method and are presented in table 3.5, which can also be visualized through a graphical representation using a Sankey diagram in figure 3.2. Although not explored in the present study, the integration of outputs from multiple legislative texts into a more comprehensive diagram could in theory provide stakeholders with a broader understanding of the internal organization and operational mechanisms of the healthcare system. Such an approach could serve as a valuable foundation for future refinement and policy development. In the second case study, CODEM was able to represent preexisting business indicators, their targets and correlations without the need to replace them with new indicators, integrating them into the previously registered legislative framework.

One limitation observed is that while the identification of actors is generally explicit in the original legislation (with few exceptions), their hierarchical level or governance sphere is often not clearly stated. This information typically must be inferred or researched based on the institutions referenced, which could lead to errors. In the compliance indicator creation phase, the segregation of operational and active indicators allowed the compliance indicators to be directed toward aspects that are practically meaningful for users during the monitoring of the most relevant tasks. In the data representation phase, the prototype management dashboards were able to display compliance at different levels of aggregation. Practical and direct responses for health managers appear to emerge from these representations, such as the global and specific level of organizational compliance with each piece of legislation.

From the perspective of a software engineer, particularly requirements engineer, working with legislation in a structured, quantifiable and representable format significantly facilitates the development of digital tools for compliance and management support. When the client user and the engineer collaborate using this shared foundation of clarity and agile interpretation, the

chances of delivering more effective and impactful artifacts are naturally enhanced. This integrated approach may provide a conceptual basis for improving current practices.

All these elements seem to support the perception that CODEM is capable of increase clarity in the interpretation of Quebec health legislation. However, the available data is not sufficient to confirm this. Until the method is successfully applied to a statistically significant volume of available legislation and validated by users, possibly through structured interviews, it remains premature to assert this conclusion.

(2) Increasing efficiency of interpretation

Considering the dozens or even hundreds of regulations that each user may need to comply with depending on the business area, this could represent significant time savings and improved efficiency in compliance processes. It may also reveal more subtle dynamics, such as the tendency of governments to legislate primarily for their own administrative structures, which could be addressed through alternative strategies.

CODEM introduces the possibility of generating an automated and high-level interpretation of a regulation's intent and practical implications for prospective users, without requiring a detailed preliminary reading and analysis of the full legal text. However, these two attributes, speed and automation, were not tested in the present study and cannot be confirmed by the available data. They remain speculative in nature. The manual classification process used in the present study is time-consuming, requires significant attention, and is subject to interpretation errors, although it produces a highly useful classification artifact. The use of machine learning techniques, particularly within the field of Natural Language Processing (NLP), appears to be a promising and inevitable path for the evolution of this approach. Their systematic application, in a verifiable and rigorous manner aimed at ensuring the quality and reliability of interpretation, may represent a significant leap in efficiency for users in appropriating legislation and applying it in daily operations and business management.

(3) Operationalizing tasks and metrics

In the first case study, CODEM operated by making explicit the subject-verb-object logic underlying each segment of the legislation, subsequently grouping these segments according to their strategic purpose and expected practical use. This process is essentially carried out through the definition of tasks for each actor. The execution of these tasks represents instances that can be quantified in terms of their completion, forming the basis for the compliance measures used. In the second case study, CODEM was employed to structure existing indicators published by the government in official action plans and dashboards, rendering them compatible with integration across different levels of legislation.

At this stage, in addressing the tasks and responsibilities prescribed by legislation, we encountered a critical issue related to information transparency. Governments and institutions, whether public or private, typically treat operational data as internal assets linked to their process management and quality control systems. While such data may occasionally be accessed by audits for certification, risk mitigation or quality assurance purposes, they are rarely made publicly available. An obstacle that became evident during the execution of this study.

Although low compliance may entail operational, managerial and even political risks for institutions, this concern is distinct from the broader issue of weak governance over compliance with the legislation itself. The latter undermines the integrity of the health system model and contributes to the development of digital tools that fail to deliver strategic value. In this context, CODEM can serve as a valuable ally by enabling a structured and technically grounded interpretation of the source legislation, thereby supporting teams in aligning their operations with regulatory expectations.

Other possibility opened by the method is the generation of automated checklists based on the mapped tasks specific to each actor. In addition to facilitating the systematization and execution of tasks for each user group, such mapping may have more subtle implications. For instance, by revealing the number of tasks assigned to each actor, it opens the possibility of

supporting discussions about the feasibility and capacity of each actor to sustain these tasks and the impact on their respective operations.

On the other hand, the interpretation of the meaning of each statement translated into tasks is context dependent and subject to a certain degree of subjectivity. This significantly increases the risk of intra and inter observer variability, potentially leading to multiple or even incorrect classifications of the same task. One way to mitigate this risk would be the use of standardized semantic ontologies for classification, including the treatment of antonyms and synonyms built from CODEM's logic. Nevertheless, the most effective approach might be to centralize this classification in a single source, preferably the legislator, who could minimize this risk by releasing a version previously standardized by CODEM alongside the traditional version of the policy.

In the second case study, unlike the first, the logic was to display existing indicators rather than recreate them. Although the method can also be used to classify informative texts, its practical utility for this purpose appeared limited, as the result does not allow for the definition of executable tasks that can be verified for compliance. We observed that the numerical tables in question could be adequately coded using the method, based on the logic of subject, verb, and object. This was true even for goals and for nonverbal relationships expressed by the structure of the table, such as the correlation between indicators and their respective strategic objectives across different columns.

(4) Facilitating feedback

Just as software and dashboards are digital artifacts derived from the application of information technology techniques, different pieces of legislation are human artifacts resulting from processes of reflection, negotiation and deliberation. When modeling a policy, it is expected that the legislator seeks to imprint a practical impact on the reality that the regulation aims to address. Measuring this impact is a challenging aspect that lies beyond the scope of this discussion. However, any reverse feedback to legislators regarding the degree of success of such application, particularly in the form of automated feedback mechanisms, has the potential to support policy modeling and the pursuit of effectiveness.

CODEM, by enhancing clarity and efficiency in how actors interact with legislation and by integrating various legislative texts and indicators into a unified and hierarchical structure, establishes a foundation through which feedback to legislators may be generated. For instance, indicators that fall significantly below their targets may suggest that certain policies or mechanisms require revision. Similarly, a high concentration of tasks assigned to a limited number of actors may prompt reflection on whether these actors are adequately equipped to respond effectively and in a timely manner.

A third concern involves the extent to which CODEM results align with the purposes stated in the preamble of each piece of legislation. In the first case study, for example, the legislation outlined four objectives: promoting access to family doctors, promoting access to specialized medicine, increasing access to primary services, and improving the management of this access. To what extent are the tasks identified within the policy synergistic with these objectives? To what degree might they have deviated from the original intent? This question is particularly relevant for legislators and senior health system managers, as a low level of alignment between tasks and stated purpose may indicate poorly formulated policies or objectives. Consequently, high or low compliance with these tasks would carry entirely different implications for the performance and outcomes of the health system.

These aspects were not explored in the present study, which does not provide results to support such discussion. However, they appear to represent a promising area for academic inquiry, particularly regarding how digital tools may empower legislators with this type of information to improve the modeling of their policies.

(4) Enabling practical solutions

The simultaneous publication by the legislator of a digital version parameterized through CODEM, alongside the traditional format of the same legislation, could add significant value to both the legislative process and the stakeholders involved.

With a single action, this version could be distributed across the entire network of users and connected systems, replacing previous legislation and enabling automated processing of the updated parameters. From the user's perspective, this would not only reduce the ambiguity typically associated with legislative texts, particularly those at a high level, but also facilitate the execution of tasks at both operational and compliance levels. Moreover, it would enable structured feedback to legislators regarding the practical applicability of health policies. The architecture for delivering such a solution could be built upon Restful APIs, leveraging existing interoperability standards such as HL7 FHIR. This approach would allow for the reuse of existing infrastructure and electronic health record databases, thereby supporting improvements in both legislative compliance and health system management.

These possibilities were not explored in the present study from the standpoint of feasibility or implementation. They remain as potential avenues for future development.

5.3 Related Works

We identified a recent work in the literature whose semantic model resembles the present study in its use of actor and task elements aimed at the automated interpretation of legal texts (Bartolini et al., 2019). However, its implementation, domain, and objectives differ. Another identified work uses actors and actions in an ontological model aimed at compliance, however

focused on specific legislation (Bella et al., 2023). Some of the works identified in the literature explore the idea of connecting business processes and regulatory compliance through technological approaches, which also brings them closer to the present study. Some of these works even highlight the challenge of keeping business processes aligned with legislation that is constantly changing (Bukša et al., 2015). The strategies and approaches differ, however, from the proposal, as well as in the degree of automation.

The issue of automating the extraction of elements from unstructured legislative texts has been explored in various studies, employing a range of technological approaches, most of which involve machine learning techniques. For instance, (Elluri et al., 2021) propose several such methods, including the identification of roles analogous to the definer, performer and receiver used in our work, which they refer to as key entities. We acknowledge the importance and necessity of this approach, particularly due to its scalability. However, we also emphasize the value of exploratory studies in the healthcare domain to deepen our understanding of the meaning and interrelations among these actors, tasks and spheres. Such insights are essential for developing models capable of encompassing and representing the broadest possible range and diversity of health-related legislation.

A study from 2015 that caught our attention, showing synergy with our current research, already highlights the importance and the challenges software engineering faces when ensuring compliance with legislation. The authors offer insights into the application of pattern recognition techniques in this context, underlining both the potential and the complexity of automating compliance verification (Fernandez & Yimam, 2015). We did not use the structured technique proposed by the author, but we also empirically perceived the high degree of similarity between elements of health legislation, which allowed us to propose the methodology of this study.

5.4 Limitations of The Study

These correspond to aspects that the research was unable to adequately control or address, without generating biases that invalidate the study.

First, *time and resource constraints* posed significant challenges to the research. Direct engagement with Quebec's health-system managers and their teams proved difficult, as did access to provincial public databases and records documenting the system's legislative compliance processes. These limitations, combined with the time restrictions inherent to the graduate program, confined the study's data sources to formal and grey literature, primarily government reports and official websites. As a result, the *diversity of perspectives* was reduced, particularly those of key stakeholders most directly involved in the system's deliverables. To partially mitigate this limitation, the study incorporated publicly available legislative documents and real business indicators data, which offered *objective and verifiable elements for analysis*.

Second, the *sample size and representativeness* posed significant limitations to the study. Instead of conducting an extensive classification of all health-related legislation in Quebec, the research employed a non-random selection strategy based on convenience sampling. This methodological choice may have *constrained the generalizability and scope* of the findings, resulted in more superficial analyses, diminished the likelihood of identifying edge cases relevant to the proposed model, and could introduced minor systematic selection biases. To mitigate these limitations, the study deliberately selected legislation across varying levels of decision-making and abstraction and clearly articulated the selection criteria, primarily grounded in the maturity and relevance of the policies. Furthermore, transparency in the methodological process, including the full reproduction of tables containing raw and processed data at different stages of classification, was intended to partially offset these constraints and enhance the study's credibility.

Given the demonstrated feasibility of the method in this exploratory study, the use of machine learning techniques in future research could significantly enhance the scale of understanding and validation, potentially paving the way for new applications.

5.5 Threats to Validity and Mitigation

Construct Validity

Construct validity evaluates whether the methods of research accurately represent the theoretical concepts being studied. This study uses health policies as the foundation for its methodology. A comparison between the policy triangle framework (Walt & Gilson, 1994) and the semantic data model applied in two case studies shows strong alignment. Stakeholder tools and norms match the actors and content components of the framework. The process component differs: the triangle focuses on stages such as formulation, negotiation, implementation, and evaluation, while the study emphasizes tasks related to care and administrative procedures within the policies. The context dimension, which includes situational, structural, cultural, and external factors, is not used in this study. Instead, it is replaced by the sphere of action of the actors, which is incorporated into the model. This difference does not compromise validity, since the triangle was designed to analyze the development of policies, while the study examines their result, which is formal and complementary legislation.

The compliance indicator, based on task completion percentage, is a basic process metric. Its compilation and interpretation are straightforward but subject to biases from user-defined goals and interpretations, which reduce comparability. Standardization of tasks and targets by the government of Quebec would likely improve its validity. Random variation in the numerator, denominator, and targets does not threaten validity, since actual data collection would yield comparable whole numbers. Despite its limitations, the indicator is considered valid for its intended role in monitoring legislative task implementation.

Credibility (Internal Validity)

In the context of a qualitative study, internal validity involves asking whether the findings and interpretations accurately reflect the context being studied. Our perception is that the method can reflect the studied context as represented in the existing legislation. The analysis revealed consistent patterns across the different data sources examined, accomplished through two levels of abstraction. The method also showed the ability to incorporate existing business indicators. In addition, the elements identified during the decomposition process aligned with a traditional method commonly used to interpret such legislation.

However, in the absence of a clear gold-standard benchmark, it becomes challenging to assess the method's precision or to identify overlooked scenarios that could undermine its conclusions. The incorporation of other active policies would significantly reinforce confidence in the approach by offering broader contextual. While the method could have practical and commercial potential, its capacity to enhance software engineering outcomes remains unverified until it undergoes thorough business-based evaluation. As a result, unresolved risks to internal validity persist and should be addressed through future research.

Transferability (External Validity)

The method appears to be sufficiently operational to be applied across different legal domains and contexts. Actors, spheres of authority, and tasks are recurring elements in legislation across multiple domains of knowledge, and it is difficult to envision a compliance setting where these components would not be present. Tests we conducted with different pieces of legislation, although not replicated in the present study, showed good adherence to the method. This supports our expectation of transferability. However, this perception is not yet supported by empirical evidence. As previously noted, as an exploratory study, the absence of a gold-standard benchmark makes it difficult to assess the method's suitability with precision. A systematic evaluation of the method is needed not only across the full scope of Quebec's health legislation, but also in other provinces and at the federal level. External validity in other domains would likewise require dedicated studies.

Confirmability (Objectivity)

Indicates the degree to which study results reflect data or participants' perspectives rather than researcher biases or preconceptions. The lack of direct access to stakeholders represents a significant risk in this work. We cannot yet confirm whether the experiences of developers, legislators, managers and teams were faithfully interpreted or whether the organizational context was described in enough depth to support our conclusions. We also recognize that task classification after decomposition depends on the observer and is subject to internal and external variability.

By using the official text of the public health legislation as our analysis subject, which is publicly available, we introduced objectivity into the study. To strengthen confirmability, we made our data collection and analysis processes fully transparent and traceable so others can review how interpretations emerged from the raw material. This approach makes any observer bias easier to detect and correct by independent reviewers.

Dependability (Reliability)

This concept refers to the consistency of results over time, even when the context that supports the method changes. A key risk is that the method depends on legislation, which can vary significantly in its writing style and may include or exclude essential elements. Still, we believe the proposed method is highly resilient to such changes, as it relies on semantic components that are fundamental to any legal contex. Tasks, responsibilities, and actions will always be carried out by different actors at various levels of authority. Regardless of how these elements are recorded, their extraction and organization remain feasible.

Several factors reinforce the method's reliability. It is easily auditable by other researchers, and its application across different types of legislation supports triangulation, since consistent results emerge from diverse data sources. The coding system is clear and replicable and can be structured directly from the source, ideally by the government. Including managers, software developers, and health professionals in the method's maintenance and evolution is both

feasible and beneficial. This collaborative approach helps reduce bias and ensures long-term sustainability.

5.6 Trade-off Between Threats

The method's current credibility (internal validity) relies on a few common elements: actors, spheres and tasks, which we consider sufficient for this study. While theoretically incorporating additional elements to capture a wider range of legislative diversity could strengthen internal validity, it would likely undermine the method's resilience to contextual changes (dependability), by increasing the number of criteria to be met. Conversely, enhancing transferability (external validity), may lead to excessive simplification and poorer alignment with local regulatory contexts, thus eroding internal validity. Strict standardization of the method may bolster its internal credibility but does so at the expense of external validity and reliability in new contexts.

Considering these trade-offs, the optimal calibration proposed in this study is to preserve the method's simplicity, thereby facilitating government adoption and maximizing external validity even at the expense of internal validity, confirmability, and dependability. Because legislation inherently operates as a top-down regulatory mechanism, a streamlined standardization process ideally operationalized by government authorities would further encourage its uptake.

CONCLUSION

This chapter summarizes the contributions of the study, offering reflections on its academic and business implications, with a particular emphasis on software engineering. Finally, it presents relevant recommendations for future research in the field

Summary of Research

In this study, we identified several gaps that software engineering can help address, particularly in the domains of governance and compliance in healthcare. We introduced the CODEM and performed manual testing, a method to systematically deconstruct and classify legislation into four fundamental components (actors, spheres, actions, and objects) based on the well-established Policy Triangle Framework (Walt & Gilson, 1994). We applied this method to the healthcare sector in Quebec, beginning with an analysis of how health legislation is structured across local, provincial, and federal levels. We then conducted two case studies at different levels of abstraction: one involving a general law, and the other a government action plan that includes business indicators. In both cases, we achieved a satisfactory conversion.

We also developed a data model capable of linking the various elements identified in the first case study, as well as organizing multiple layers of health legislation in a hierarchical structure, as demonstrated in the second case study. To validate our method, we built two functional dashboard prototypes using Power BI, illustrating how the proposed method and data model can be used to assess and visualize legislative compliance rates according to different criteria. Finally, we analyzed and discussed our findings considering existing literature, reflecting on the study's limitations and potential threats to its validity.

Academic Implications

From an academic perspective, this research does not introduce new methodologies or paradigms within the field of software engineering. However, the study highlights areas that remain largely unexplored regarding the role of software engineering in enhancing the governance of national and provincial health systems, which are marked by dispersion and complexity, and present considerable technical challenges.

The research presents an unconventional method by proposing the decomposition and use of legislation as input for digital artifacts (CODEM), offering an alternative to traditional document indexing strategies. It provides a feasible and theoretically supported pathway for this incorporation, adapting a recognized health policy framework for practical use by software development teams.

This work also contributes to a still underexplored niche within RegTech and SupTech applied to the healthcare sector, offering insights that may encourage further investigation. The method has the potential to inspire researchers in software engineering and health informatics to develop more robust methodologies and digital artifacts with stronger academic relevance and practical utility.

Business Implications

The proposed method enables regulatory authorities to develop structured, complementary policy versions that provide precise guidance to stakeholders. In a future ideal scenario, when a new legislative text is published in the traditional narrative format, the legislator simultaneously may release a structured and classified digital version, aligned with CODEM standards, and made accessible to the entire network of stakeholders. This strategy would enhance stakeholders' understanding of their responsibilities and the government's intended operational framework while affording software developers clear requirement specifications for building tools aligned with both regulatory objectives and end user needs.

The study facilitates alternative perspectives on information that enhance business value. By categorizing data according to stakeholder role, governance domain, task type, strategic level, or degree of compliance, it supports the development of targeted compliance metrics and representations that address identified gaps. This could increase compliance and bring the theoretical healthcare model closer to its real-world implementation.

CODEM could also serve as a foundation for software developers seeking to construct multilevel digital representations of existing legislation. It could provide regulators and managers with clearer oversight of how these laws interconnect across different levels, from high-level health system modeling to operational indicators. If appropriately applied, it could assist in promoting compliance and quality management, and in strengthening healthcare systems and their associated tools.

Similarly, the case studies demonstrated that the identified elements can be effectively translated into metrics and representations with potential value for healthcare managers and teams. However, these metrics and representations require further refinement to ensure alignment with user needs and organizational priorities.

Overall, CODEM performed as anticipated, reinforcing our confidence in its potential applicability to a broader spectrum of legislation and even to other domains. The broader applicability of the method remains speculative, as it is not yet supported by empirical evidence. Nonetheless, numerous technologies are already available that could enable the present research idea to be pursued on a larger scale and with greater automation (Gyory et al., 2023).

Recommendations for Future Research

Automation and Scale

The foundational logic established in this research, invites further efforts to automate the proposed method, potentially utilizing natural language processing techniques guided by the defined semantic model. As the volume and complexity of decoded and classified legislation grow, automation will help validate and refine the method while promoting an integrated perspective across diverse regulatory models. These efforts can also support standardization and procedural implementation in regulatory and operational environments, reducing errors and improving traceability.

Method Validation

Additional research is needed to strengthen both the internal and external validity of the construct and to test its applicability inside and beyond healthcare. Empirical studies should assess whether the method remains simple to implement and highly useful to end users while maintaining resilience to contextual changes. Future work must carefully balance trade-offs between broad applicability and domain-specific requirements to optimize the method's utility.

Framework Comparison

The current method relies on a partial adaptation of a contextual framework for legislative analysis, but alternative theoretical models deserve comparative testing. Robust and quantitative research designs with diverse independent variables can determine which frameworks best support legislative decoding and classification. Such comparisons will extend beyond the exploratory nature of the present study and provide prescriptive guidance for framework selection.

Requirements Engineering

A deeper understanding of stakeholder needs and pain points is essential for effective tool design. Structured interviews, co-design workshops, and prototype testing can reveal latent requirements and improve user acceptance. Investigating how the method applies across varied business contexts will clarify the role of software engineering in addressing these challenges.

User Experience and Human-Centered Design

There is a significant gap in how users perceive regulations and engage with compliance tools, maybe sometimes viewing regulation as needless bureaucracy or an endless maze. By uncovering underlying mental models and revealing regulatory logic, new related research can shift perceptions, extend the method's reach, and foster greater ownership of compliance tasks. Integrating and aligning regulations across multiple levels maybe could further promote proper method adoption and deliver improved business outcomes.

Software Architecture and Interoperability

When the Quebec government adopts a digital specification method for its legislation, research must focus on identifying optimal architectural frameworks and deployment strategies for these solutions. Key considerations include the definition of interoperability standards and the establishment of best practices for information recording. Employing databases compliant with the HL7 FHIR standard (not only for transactional interactions with electronic health records, but also for modeling national and provincial health systems) maybe could serve as a foundational approach. Furthermore, developing an implementation guide that leverages a native FHIR API may offer a strategic pathway toward this real-world adoption and scalability.

Multilevel Visual Modeling of Health Systems

There is a notable absence of visual models that represent healthcare systems holistically, particularly those anchored in their legislative foundations. Current visual representations of health systems typically appear as hierarchical diagrams resembling organizational charts.

Drawing from the core components mapped by the method, CODEM could assist in building digital, layered visualizations of comprehensive health system structures. Addressing this software engineering challenge will offer substantial value to administrators, regulators, and other users.

APPENDIX I

First Case Study - Original Legislation Text

Legislative Text – Original content of the document
Act to promote access to family medicine and specialized medicine services
(chapter A-2.2, ss. 11, 1st par. and 11.1, 3rd par.)
Taken from Légis Quéebec (Québec, 2025a)

Act to promote access to family medicine and specialized medicine services
(chapter A-2.2, ss. 11, 1st par. and 11.1, 3rd par.).
Act to increase the supply of primary care services and to improve the management of that supply
(2022, chapter 16, s. 1).
DIVISION I
ADDING OF PERSONS TO GENERAL PRACTITIONERS' CASELOAD OF PATIENTS
O.C. 800-2024, Div. I.
1. General practitioners may add to their caseload of patients a person other than a person registered in the system referred to in subparagraph 1 of the first paragraph of section 11 of the Act to promote access to family medicine and specialized medicine services (chapter A-2.2), replaced by section 1 of the Act to increase the supply of primary care services and to improve the management of that supply (2022, chapter 16), if the addition considered corresponds to one of the following cases:
(1) a member of the person's immediate family is already registered with the practitioner;
(2) the practitioner takes over for another health and social services professional and the person was registered with that other professional; or
(3) the person is unable to register with the system.
For the purposes of the first paragraph, member of the person's immediate family means
(1) the person's father and mother or relatives;
(2) the person's spouse, child and child of the person's spouse; and
(3) a dependent child of the person.
O.C. 800-2024, s. 1.
2. In addition to the cases described in section 1, general practitioners may add to their caseload of patients a person other than a person registered in the system referred to in that section if, on the one hand, the practitioner has already cared for the person for an episode of care or for specific monitoring and, on the other hand, the person satisfies the conditions set out in one of the following paragraphs:
(1) the person is in one of the following situations:
(a) the person is suffering from active cancer;
(b) the person is receiving palliative care;
(c) the person has a psychotic disorder;
(d) the person has suicidal or homicidal ideation;

(e) the person is pregnant;
(f) the person is in a situation of the same nature as those referred to in subparagraphs a to e for which a registration delay of 7 or more days could have adverse consequences on the person's health;
(g) the person was hospitalized for a chronic problem or a problem requiring rapid follow-up in the month preceding the person's request to be added to the practitioner's caseload of patients;
(h) the person has an active drug or alcohol addiction;
(i) the person has a major and active depressive, adjustment or anxiety disorder;
(j) the person has HIV or AIDS;
(k) the person has had a recent embolism or atrial fibrillation requiring the person to take anticoagulants and that the international normalized ratio (INR) calculated for blood clotting be monitored;
(l) the person is in a situation of the same nature as those referred to in subparagraphs g to k for which a registration delay of not more than two weeks can be tolerated;
(2) the person is not in a situation described in paragraph 1, but being added to the practitioner's caseload of patients is not done to the detriment of a person in such a situation who is registered in the system referred to in section 1.
O.C. 800-2024, s. 2.
DIVISION II
HOURS OF AVAILABILITY OF GENERAL PRACTITIONERS
This Division comes into force on 23 November 2025 with regard to any general practitioner who, on 23 May 2024, does not use the booking mechanism for requests for care and for the management of primary care services (D. 808-2020, 2020-07-15, French only).
O.C. 800-2024, Div. II.
3. General practitioners must offer all their hours of availability using any appointment booking system referred to in subparagraph 2 of the first paragraph of section 11 of the Act to promote access to family medicine and specialized medicine services (chapter A-2.2), replaced by section 1 of the Act to increase the supply of primary care services and to improve the management of that supply (2022, chapter 16).
O.C. 800-2024, s. 3.
This section comes into force on 23 November 2025 with regard to any general practitioner who, on 23 May 2024, does not use the booking mechanism for requests for care and for the management of primary care services (D. 808-2020, 2020-07-15, French only).
4. Each period of hours of availability to be sent to the Minister by general practitioners under the third paragraph of section 11.1 of the Act to promote access to family medicine and specialized medicine services (chapter A-2.2), enacted by section 1 of the Act to increase the supply of primary care services and to improve the management of that supply (2022, chapter 16), must specify:
(1) the date on which the hours of availability became accessible for the booking of appointments, and the times at which the hours begin and end;
(2) the category of persons for whom the hours of availability are offered from among the following:
(a) a person registered with the practitioner;
(b) a person registered with another practitioner practising in the same place;

(c) a person registered with another health and social services professional practising in the same place;
(d) any other person;
(3) the reason for consultation for which the hours of availability are offered from among the following:
(a) urgent consultation;
(b) semi-urgent consultation;
(c) pregnancy monitoring;
(d) pediatric follow-up;
(e) regular check-up;
(4) if applicable, the source redirecting the person for whom the hours of availability are offered from among the following:
(a) 811 call;
(b) 911 call;
(c) Primary Care Access Point;
(d) hospital centre;
(5) the consultation method to be used for which the hours of availability are offered from among the following:
(a) attendance at the place where the practitioner practises during the hours of availability;
(b) attendance at the person's domicile;
(c) remotely, by videoconference;
(d) remotely, by telephone; and
(6) the name and contact information of the place where the practitioner practises during the hours of availability.
O.C. 800-2024, s. 4.
This section comes into force on 23 November 2025 with regard to any general practitioner who, on 23 May 2024, does not use the booking mechanism for requests for care and for the management of primary care services (D. 808-2020, 2020-07-15, French only).
5. The following information must be provided with the information specified in the hours of availability referred to in section 4 where those hours cease to be available owing to an appointment being made other than by a system provided for in section 3:
(1) the name of the person obtaining the appointment;
(2) the person's health insurance number;
(3) the person's date of birth;
(4) the person's sex;
(5) the postal code of the person's place of residence; and
(6) the contact information enabling the person to be reached.
The information listed in the first paragraph must be entered in the appointment booking system used by the practitioner by any means taken by the Minister under the second paragraph of section 11.1 of the Act to promote access to family medicine and specialized medicine services (chapter A-2.2), enacted by section 1 of the Act to increase the supply of primary care services and to improve the management of that supply (2022, chapter 16).
O.C. 800-2024, s. 5.

This section comes into force on 23 November 2025 with regard to any general practitioner who, on 23 May 2024, does not use the booking mechanism for requests for care and for the management of primary care services (D. 808-2020, 2020-07-15, French only).

6. For each 4-week period beginning on a Sunday, the information listed in section 4 is to be sent to the Minister not later than 24 hours before the beginning of the period and, without delay, whenever hours of availability allotted to a person again become available in particular because a consultation has been cancelled.

The information listed in section 5 is to be sent to the Minister without delay.

O.C. 800-2024, s. 6.

This section comes into force on 23 November 2025 with regard to any general practitioner who, on 23 May 2024, does not use the booking mechanism for requests for care and for the management of primary care services (D. 808-2020, 2020-07-15, French only).

7. The information listed in sections 4 and 5 is to be sent to the Minister using an electronic medical record allowing for the information to be sent in compliance with section 6.

O.C. 800-2024, s. 7.

This section comes into force on 23 November 2025 with regard to any general practitioner who, on 23 May 2024, does not use the booking mechanism for requests for care and for the management of primary care services (D. 808-2020, 2020-07-15, French only).

DIVISION III

TRANSITIONAL AND FINAL

O.C. 800-2024, Div. III.

8. Until the coming into force of a regulation made under subparagraph 1 of the second paragraph of section 92 of the Act respecting health and social services information (chapter R-22.1) providing for the certification procedure of an electronic medical record, the electronic medical record referred to in section 7 must be certified in accordance with the rules, as the case may be,

(1) made for the integration of section 5.2 of the Act respecting the Ministère de la Santé et des Services sociaux (chapter M-19.2);

(2) deemed to have been made under section 97 of the Act respecting health and social services information by section 263 of the Act.

O.C. 800-2024, s. 8.

9. Sections 3 to 7 do not apply to general practitioners aged 65 or more on 23 May 2024 who, at that time, do not use the booking mechanism for requests for care and for the management of primary care services referred to in Order in Council 808-2020 dated 15 July 2020.

O.C. 800-2024, s. 9.

10. (Omitted).

O.C. 800-2024, s. 10.

REFERENCES

O.C. 800-2024, 2024 G.O. 2, 1722

APPENDIX II

First Case Study – Sample Transcribed and Formatted Results

Table-A II-1 Sample of Policy after Classification

#	ADJUSTED TEXT
1	1. The purpose of this Act is to optimize the utilization of the medical and financial resources of the health system with a view to improving access to family medicine and specialized medicine services.
2	(1) the expression “institution” means a public institution or a private institution under agreement within the meaning of the Act respecting health services and social services (chapter S-4.2);
3	(2) the expression “president and executive director” also means the executive director of a private institution under agreement;
4	(3) the regional department of general medicine is the one established under section 417.1 of the Act respecting health services and social services and
5	the regional department of general medicine (...) exercises the responsibilities conferred on it under the authority of the president and executive director of the integrated health and social services centre, within the meaning of the Act to modify the organization and governance of the health and social services network, in particular by abolishing the regional agencies (chapter O-7.2), to which it belongs.
6	3. The institutions referred to in Schedule I are not subject to this Act.
7	4. Every general practitioner subject to an agreement entered into under section 19 of the Health Insurance Act (chapter A-29) must, to the extent prescribed by government regulation, (1) provide, individually or with other physicians within a family medicine group, medical care to a minimum caseload of patients; and
8	4. Every general practitioner subject to an agreement entered into under section 19 of the Health Insurance Act (chapter A-29) must, to the extent prescribed by government regulation, (2) perform, for the benefit of the users of an institution, a minimum number of hours of medical activities that is authorized by the regional department of general medicine in the general practitioner’s region in accordance with section 7.
9	The government regulation may, in particular, prescribe (1) the age as of which a physician is exempted from those obligations;
10	The government regulation may, in particular, prescribe (2) the terms governing the medical care provided to patients;
11	The government regulation may, in particular, prescribe (3) the minimum patient caseload;
12	The government regulation may, in particular, prescribe (4) the medical activities that may be authorized under section 7;
13	The government regulation may, in particular, prescribe (5) the minimum number of hours of medical activities that must be performed;
14	The government regulation may, in particular, prescribe (6) the special rules that apply when a physician wishes to engage in medical activities in more than one region; and
15	The government regulation may, in particular, prescribe (7) any other condition a physician must comply with to fulfil those obligations.
16	5. Every institution’s director of professional services determines, in accordance with the directives the Minister sends to the institutions, the number of hours of medical activities available in each centre operated by the institution
17	Every institution’s director of professional services informs the regional department of general medicine in the director’s region.

APPENDIX III

First Case Study – Sample of Classification of Legislation

Table-A III-1 Content of the document from appendix after the classification process

PERFORMER					RECEIVER				
ACTOR	ACTION	OBJECT	TASK TYPE	PRACTICAL USE	ACTOR	ACTION	OBJECT	TASK TYPE	PRACTICAL USE
Local Provider Physician	Set rule	Infomation content	Operational	Informative	Provincial Government	Receive information	Receive Medical Activities Choosen	Operational	Passive
Provincial Government	Set Role	Authorize Minimum Workload	Operational	Active	Local Provider Physician	Perform task	Comply with minimum workload	Operational	Active
Provincial Government	Set Role	Authorize Other Workload	Operational	Active	Local Provider Physician	Perform task	Comply with special workload	Operational	Active
Provincial Government	Send Information	Inform Workload Exemption	Operational	Active	Provincial Government	Receive information	Receive Workload Exemption	Operational	Passive
Provincial Government	Perform task	Review Workload Exemption	Tactical	Active	Provincial Government	Set Role	Review Workload Exemption	Tactical	Informative

APPENDIX IV

First Case Study – Sample of Classification by Governance Level and Object

This table presents, for each level of strategic governance aggregation, the frequency associated with each actor and task. “Ope”, “Str” and “Tac” are the operational, strategic and tactical categories from type of task variable, respectively.

Table-A IV-1 Content of the document from appendix I after the classification process.

#	Actor	Action	Object	OPE	STR	TAC	Total
1	Provincial Government	Set Rule	Define services costs extension	2			2
2	Provincial Government	Set Rule	Define actor	3			3
3	Provincial Government	Set Rule	Define Amendments vigence limits	1			1
4	Provincial Government	Set Rule	Define Care Terms			1	1
10	Provincial Government	Set Rule	Define Legislation Exclusion	2			2
61	Provincial Government	Perform task	Comply with tabled frequency	1			1
62	Provincial Government	Perform task	Decide on revision request	1			1
63	Provincial Government	Perform task	Declare physician in default	2			2
64	Provincial Government	Perform task	Deliver notice compliance	1			1
65	Provincial Government	Perform task	Detects impossibility of reduction.	1			1

APPENDIX V
First Case Study - Classification by Actor and Practical Use

Table-A V-1 Content of the document from appendix I after the classification process. This table presents, for each level of practical use aggregation, the frequency associated with each actor and task

Rótulos de Linha	Active	Informative	Passive	Total
Local Provider Leadership	**14**	**1**	**3**	**18**
Perform task	**9**			**9**
Analyze changes in circumstances	1			1
Analyze physician compliance	1			1
Comply instituition number hours	1			1
Receive information			**3**	**3**
Receive changes in circunstances			1	1
Receive government decision			1	1
Receive observations about exemption			1	1
Request Information	**1**			**1**
Request exception supporting facts	1			1
Send Information	**2**			**2**
Inform Instituition number hours	1			1
Inform lost of exemption	1			1
Set Role		**1**		**1**
Verify obligation fulfillment		1		1
Set Rule	**2**			**2**
Define Service General Workload	1			1
Follow report obligation	1			1
Local Provider Physician	**45**	**2**	**11**	**58**
Perform task	**35**		**1**	**36**
Apply for obligation exemption	2			2
Comply authorized medical activities	1			1
Comply Caseload Inscription Rule	1			1
Receive information			**8**	**8**
Get timely application response			1	1
Know Exemptions results			1	1
Send Information	**10**			**10**

APPENDIX VI

First Case Study - Sample of Indicators Related to Active Tasks

Table-A VI-1 Task-Specific Indicator List

<Indicator	Actor	Action	Strategic level	Pratical use	Object	Original Text
PL-01	Local Provider Leadership	Perform Task	Operational	Active	Declares the physician in default	5. Every institution's director of professional services determines, in accordance with the directives the Minister sends to the institutions, the number of hours of medical activities available in each centre operated by the institution
PL-02	Local Provider Leadership	Perform task	Operational	Active	Analyze changes in circumstances	Every institution's director of professional services informs the regional department of general medicine in the director's region.
PL-03	Local Provider Leadership	Perform task	Operational	Active	Analyze physician compliance	18. If (...) the president and executive director concludes that the reason for which a physician was granted an exemption no longer exists, the exemption is withdrawn.
PL-04	Local Provider Leadership	Perform task	Operational	Active	Comply instituition number hours	19. The (...) or the president and executive director notifies any decision under section 16 or 18 to the physician as soon as possible.

APPENDIX VII First Case Study

Sample of Task Indicators Results

Table-A VII-1 Sample of indicators by task and actor, with corresponding numerator, denominator, and simulated compliance percentage

Indicator	Actor	Numerator	Denominator	Total	Target reached: 80%
PL-01	Local Provider Leadership	50	72	69,4%	No
PL-02	Local Provider Leadership	2	55	3,6%	No
PL-03	Local Provider Leadership	29	82	35,4%	No
PL-04	Local Provider Leadership	52	93	55,9%	No
PP-01	Local Provider Physician	40	49	81,6%	Yes
PP-02	Local Provider Physician	9	43	20,9%	No
PP-03	Local Provider Physician	22	23	95,7%	Yes
PP-04	Local Provider Physician	21	64	32,8%	No
PP-05	Local Provider Physician	72	74	97,3%	Yes
PP-06	Local Provider Physician	15	92	16,3%	No
PG-01	Provincial Government	31	72	43,1%	No
PG-02	Provincial Government	96	97	99,0%	Yes
PG-03	Provincial Government	37	71	52,1%	No
PG-04	Provincial Government	18	30	60,0%	No
PG-05	Provincial Government	12	88	13,6%	No
PG-06	Provincial Government	12	58	20,7%	No
PG-07	Provincial Government	40	42	95,2%	Yes
PG-08	Provincial Government	22	51	43,1%	No
PG-09	Provincial Government	9	86	10,5%	No
PG-10	Provincial Government	0	36	0,0%	No
PG-11	Provincial Government	34	83	41,0%	No
PG-12	Provincial Government	6	88	6,8%	No
PG-13	Provincial Government	57	89	64,0%	No
PG-14	Provincial Government	19	94	20,2%	No
PG-15	Provincial Government	25	44	56,8%	No
PG-16	Provincial Government	70	72	97,2%	Yes

APPENDIX VIII

Second Case Study - Transcript and Adjustment Results

Table-A VIII-1 Content of the document from case study 2, formatted for classification

SUMMARY TABLE
STRATEGIC PLAN 2023-2027 Ministry of Health and Social Services
ASSIGNMENT - Maintain, improve and restore the health and well-being of Quebecers by making accessible a range of health services and integrated, quality social services, contributing to the social and economic development of Québec.
VISION - Providing care to all Quebecers and accessible, quality services adapted to their needs, where their well-being is at the heart of decisions.
VALUES - Kindness, Accessibilit, Quality
Challenge 1: A more humane organization of work
Orientation 1: Become an employer of choice
GOALS - 1.1 Improve job satisfaction of Ministry staff and its network
GOALS - 1.2 Supporting the network's workforce
GOALS - 1.3 Make network staff aware of the realities indigenous people
GOALS - 1.4 Contribute to the government's effort in matters sustainable development
INDICATOR - 22. Average time to emergency care for all customers
INDICATOR - 22. Average time to emergency care for all customers - Starting time: 153 minutes
INDICATOR - 22. Average time to emergency care for all customers - TARGET 2023-2024:165 minutes
INDICATOR - 22. Average time to emergency care for all customers - TARGET 2024-2025:125 minutes
INDICATOR - 22. Average time to emergency care for all customers - TARGET 2025-2026:105 minutes
INDICATOR - 22. Average time to emergency care for all customers - TARGET 2026-2027:90 minutes
INDICATOR - 23. Average length of stay on stretcher
INDICATOR - 23. Average length of stay on stretcher - Starting measurement: 18.1 hours
INDICATOR - 23. Average length of stay on stretcher - TARGET 2023-2024:5 p.m
INDICATOR - 23. Average length of stay on stretcher - TARGET 2024-2025:4 p.m
INDICATOR - 23. Average length of stay on stretcher - TARGET 2025-2026:3 p.m
INDICATOR - 23. Average length of stay on stretcher - TARGET 2026-2027:2 p.m

APPENDIX IX

Second Case Study – Sample of Classification of Legislation

Table-A IX-1 Sample of Content of the second case study after the classification process

TASK	DEFINER			PERFORMER		
	ACTOR	ACTOR	ACTION	OBJECT	TASK TYPE	PRACTICAL USE
Challenge 1: A more humane organization of work	Provincial Government	Provincial Government	Set RULE	Set Specific Objectives	Strategic	Active
INDICATOR - 22. Average time to emergency care for all customers	Provincial Government	Provincial Government	Set TASK	Calculate periodic indicator	Operational	Active
INDICATOR - 22. Average time to emergency care for all customers - Starting time: 153 minutes	Provincial Government	Provincial Government	Set RULE	Define Starting Measuremen t Point	Operational	Informative
INDICATOR - 22. Average time to emergency care for all customers - TARGET 2023-2024:165 minutes	Provincial Government	Provincial Government	Set RULE	Define Indicator Target	Operational	Active
INDICATOR - 22. Average time to emergency care for all customers - TARGET 2024-2025:125 minutes	Provincial Government	Provincial Government	Set RULE	Define Indicator Target	Operational	Active
INDICATOR - 22. Average time to emergency care for all customers - TARGET 2025-2026:105 minutes	Provincial Government	Provincial Government	Set RULE	Define Indicator Target	Operational	Active
INDICATOR - 22. Average time to	Provincial Government	Provincial Government	Set RULE	Set Specific Objectives	Tactical	Informative

emergency care for all customers [HAS GOAL] 3.5 Ensure better accessibility to emergency services						
INDICATOR - 23. Average length of stay on stretcher	Provincial Government	Provincial Government	Set TASK	Calculate periodic indicator	Operational	Active
INDICATOR - 23. Average length of stay on stretcher - Starting measurement: 18.1 hours	Provincial Government	Provincial Government	Set RULE	Define Starting Measurement Point	Operational	Informative
INDICATOR - 23. Average length of stay on stretcher - TARGET 2023-2024:5 p.m	Provincial Government	Provincial Government	Set RULE	Define Indicator Target	Operational	Active
INDICATOR - 23. Average length of stay on stretcher - TARGET 2024-2025:4 p.m	Provincial Government	Provincial Government	Set RULE	Define Indicator Target	Operational	Active
INDICATOR - 23. Average length of stay on stretcher - TARGET 2025-2026:3 p.m	Provincial Government	Provincial Government	Set RULE	Define Indicator Target	Operational	Active
INDICATOR - 23. Average length of stay on stretcher - TARGET 2026-2027:2 p.m	Provincial Government	Provincial Government	Set RULE	Define Indicator Target	Operational	Active
INDICATOR - 23. Average length of stay on stretcher [HAS GOAL] 3.5 Ensure better accessibility to emergency service	Provincial Government	Provincial Government	Set RULE	Set Specific Objectives	Tactical	Informative

APPENDIX X

Advanced Literature Search Queries

The following algorithms represent the complete search expressions used to retrieve literature from each of the article databases consulted. They are provided here for reproducibility purposes; in case the reader wishes to replicate or refine the search strategies.

PART I – First Phase Search Algorithms (Generic)

Algorithm-A X-1 Part I - Complete Search Expression in SCOPUS using the address - https://www.scopus.com/search/form.uri?display=advanced

```
TITLE ( ( "tool" OR "software" OR "technology" OR "system" OR method* OR approach* OR techniq* OR framework* OR strateg* OR model* OR algorithm* OR process* OR architecture* ) AND ( "Adherence" OR "Conformity" OR "Conformance" OR "Observance" OR "Regulatory compliance" OR "Legal compliance" OR "Accountability" OR "Compliance" ) AND ( "Law" OR "Statute" OR "Act" OR "Bill" OR "Code" OR "Ordinance" OR "Regulation" OR "Directive" OR "Decree" OR "Policy" OR "Lawmaking" OR "Legal framework" OR "Written law" OR "Legal code" ) ) AND PUBYEAR > 2014 AND PUBYEAR < 2026 AND ( LIMIT-TO ( LANGUAGE , "English" ) ) AND ( LIMIT-TO ( SRCTYPE , "j" ) OR LIMIT-TO ( SRCTYPE , "p" ) ) AND ( LIMIT-TO ( SUBJAREA , "COMP" ) OR LIMIT-TO ( SUBJAREA , "ENGI" ) OR LIMIT-TO ( SUBJAREA , "BUSI" ) OR LIMIT-TO ( SUBJAREA , "DECI" ) OR LIMIT-TO ( SUBJAREA , "MULT" ) OR LIMIT-TO ( SUBJAREA , "HEAL" ) )
```

Algorithm-A X-2 Part I - Complete Search Expression in ACM DIGITAL LIBRARY using the address - https://dl.acm.org/search/advanced

[[Title: tool] OR [Title: software] OR [Title: technology] OR [Title: system] OR [Title: method*] OR [Title: approach*] OR [Title: techniq*] OR [Title: framework*] OR [Title: strateg*] OR [Title: model*] OR [Title: algorithm*] OR [Title: process*] OR [Title: architecture*]] AND [[Title: adherence] OR [Title: conformity] OR [Title: conformance] OR [Title: observance] OR [Title: "regulatory compliance"] OR [Title: "legal compliance"] OR [Title: accountability] OR [Title: compliance]] AND [[Title: law] OR [Title: statute] OR [Title: act] OR [Title: bill] OR [Title: code] OR [Title: ordinance] OR [Title: regulation] OR [Title: directive] OR [Title: decree] OR [Title: policy] OR [Title: "lawmaking"] OR [Title: "legal framework"] OR [Title: "written law"] OR [Title: "legal code"]] AND [E-Publication Date: (01/01/2015 TO 12/31/2025)]

Algorithm-A X-3 Part I - Complete Search Expression in IEEE XPLORE using the address - https://ieeexplore.ieee.org/search/advanced/command

(("Document Title":"tool" OR "Document Title":"software" OR "Document Title":"technology" OR "Document Title":"system" OR "Document Title":"method*" OR "Document Title":"approach*" OR "Document Title":"techniq*" OR "Document Title":"framework*" OR "Document Title":"strateg*" OR "Document Title":"model*" OR "Document Title":"algorithm*" OR "Document Title":"process*" OR "Document Title":"architecture*")

AND

("Document Title":"Adherence" OR "Document Title":"Conformity" OR "Document Title":"Conformance" OR "Document Title":"Observance" OR "Document Title":"Regulatory compliance" OR "Document Title":"Legal compliance" OR "Document Title":"Accountability" OR "Document Title":"Compliance")

AND

("Document Title":"Law" OR "Document Title":"Statute" OR "Document Title":"Act" OR "Document Title":"Bill" OR "Document Title":"Code" OR "Document Title":"Ordinance" OR "Document Title":"Regulation" OR "Document Title":"Directive" OR "Document Title":"Decree" OR "Document Title":"Policy" OR "Document Title":"Lawmaking" OR "Document Title":"Legal framework" OR "Document Title":"Written law" OR "Document Title":"Legal code"))

Algorithm-A X-4 Part I - Complete Search Expression in MEDLINE PUBMED using the address - https://pubmed.ncbi.nlm.nih.gov/advanced/

(("tool"[Title] OR "software"[Title] OR "technology"[Title] OR "system"[Title] OR method*[Title] OR approach*[Title] OR techniq*[Title] OR framework*[Title] OR strateg*[Title] OR model*[Title] OR algorithm*[Title] OR process*[Title] OR architecture*[Title]) AND ("Adherence"[Title] OR "Conformity"[Title] OR "Conformance"[Title] OR "Observance"[Title] OR "Regulatory compliance"[Title] OR "Legal compliance"[Title] OR "Accountability"[Title] OR "Compliance" [Title]) AND ("Law"[Title] OR "Statute"[Title] OR "Act"[Title] OR "Bill"[Title] OR "Code"[Title] OR "Ordinance"[Title] OR "Regulation"[Title] OR "Directive"[Title] OR "Decree"[Title] OR "Policy"[Title] OR "Lawmaking"[Title] OR "Legal framework"[Title] OR "Written law"[Title] OR "Legal code"))

Manual Filters: in the last 10 years, English

Algorithm-A X-5 Part I - Complete Search Expression in GOOGLE SCHOLAR using the address - https://scholar.google.ca

https://scholar.google.com/scholar?start=10&q=intitle:compliance+AND+intitle:regulation+AND+intitle:law+AND++(%22tool%22+OR+%22software%22+OR+%22technology%22+OR+%22system%22+OR+%22method%22+OR+%22approach%22+OR+%22technique%22+OR+%22framework%22+OR+%22strategy%22+OR+%22model%22+OR+%22algorithm%22+OR+%22process%22+OR+%22architecture%22)+AND++(%22adherence%22+OR+%22conformity%22+OR+%22conformance%22+OR+%22observance%22+OR+%22regulatory+compliance%22+OR+%22legal+compliance%22+OR+%22accountability%22+OR+%22compliance%22)+AND++(%22law%22+OR+%22statute%22+OR+%22act%22+OR+%22bill%22+OR+%22code%22+OR+%22ordinance%22+OR+%22regulation%22+OR+%22directive%22+OR+%22decree%22+OR+%22policy%22+OR+%22lawmaking%22+OR+%22legal+framework%22+OR+%22written+law%22+OR+%22legal+code%22)&hl=pt-BR&as_sdt=0,5&as_ylo=2015&as_yhi=2025&as_vis=1

PART II – Second Phase Search Algorithms (Secondary Studies)

Algorithm-A X-6 Part II - Complete Search Expression in SCOPUS using the address - https://www.scopus.com/search/form.uri?display=advanced

```
TITLE-ABS-KEY((("SupTech" OR "Supervisory Technology" OR "RegTech" OR "Regulatory Technology") AND ("literature review" OR "systematic mapping" OR "systematic review" OR "mapping study" OR "systematic map"))) AND ( LIMIT-TO ( SRCTYPE,"j" ) OR LIMIT-TO ( SRCTYPE,"p" ) ) AND ( LIMIT-TO (LANGUAGE,"English") )
```

Algorithm-A X-7 Complete Search Expression in IEEE XPLORE using the address - https://ieeexplore.ieee.org/search/advanced/command

```
(((Document Title:SupTech OR Document Title:"Supervisory Technology" OR Document Title:RegTech OR Document Title:"Regulatory Technology") OR (Abstract:SupTech OR Abstract:"Supervisory Technology" OR Abstract:RegTech OR Abstract:"Regulatory Technology") OR (Author "Keywords":SupTech OR Author "Keywords":"Supervisory Technology" OR Author "Keywords":RegTech OR Author "Keywords":"Regulatory Technology")) AND ((Document Title:"literature review" OR Document Title:"systematic mapping" OR Document Title:"systematic review" OR Document Title:"mapping study" OR Document Title:"systematic map") OR (Abstract:"literature review" OR Abstract:"systematic mapping" OR Abstract:"systematic review" OR Abstract:"mapping study" OR Abstract:"systematic map") OR (Author "Keywords":"literature review" OR Author "Keywords":"systematic mapping" OR Author "Keywords":"systematic review" OR Author "Keywords":"mapping study" OR Author "Keywords":"systematic map")) )
```

Algorithm-A X-8 Part II - Complete Search Expression in ACM DIGITAL LIBRARY using the address - https://dl.acm.org/search/advanced

Title OR Abstract OR Keyword
(SupTech OR Supervisory Technology OR RegTech OR Regulatory Technology)
+
Title OR Abstract OR Keyword
(literature review OR systematic mapping OR systematic review OR mapping study OR systematic map)

Algorithm-A X-9 Part II - Complete Search Expression in GOOGLE SCHOLAR using the address - https://scholar.google.ca

(intitle:"SupTech" OR intitle:"Supervisory Technology" OR intitle:"RegTech" OR intitle:"Regulatory Technology")
AND
(intitle:"literature review" OR intitle:"systematic mapping" OR intitle:"systematic review" OR intitle:"mapping study" OR intitle:"systematic map")

Algorithm-A X-10 Part II - Complete Search Expression in MEDLINE PUBMED using the address - https://pubmed.ncbi.nlm.nih.gov/advanced/

(("SupTech"[Title] OR "Supervisory Technology"[Title] OR "RegTech"[Title] OR "Regulatory Technology"[Title])) AND (("literature review"[Title] OR "systematic mapping"[Title] OR "systematic review"[Title] OR "mapping study"[Title] OR "systematic map"[Title]))

PART III – Third Phase Search Algorithms (Healthcare)

Algorithm-A X-11 Part III - Complete Search Expression in SCOPUS using the address - https://www.scopus.com/search/form.uri?display=advanced

TITLE-ABS-KEY((("SupTech" OR "Supervisory Technology" OR "RegTech" OR "Regulatory Technology") AND (health* or medic*))) AND (LIMIT-TO (SRCTYPE,”j”) OR LIMIT-TO (SRCTYPE,”p”)) AND (LIMIT-TO (LANGUAGE,”English”))

Algorithm-A X-12 Part III - Complete Search Expression in IEEE XPLORE using the address - https://ieeexplore.ieee.org/search/advanced/command

(("Document Title":"SupTech" OR "Document Title":"Supervisory Technology" OR "Document Title":"RegTech" OR "Document Title":"Regulatory Technology" OR "Abstract":"SupTech" OR "Abstract":"Supervisory Technology" OR "Abstract":"RegTech" OR "Abstract":"Regulatory Technology" OR "Author Keywords":"SupTech" OR "Author Keywords":"Supervisory Technology" OR "Author Keywords":"RegTech" OR "Author Keywords":"Regulatory Technology") AND ("Document Title":"health*" OR "Document Title":"medic*" OR "Document Title":"MedTech" OR "Abstract":"health*" OR "Abstract":"medic*" OR "Abstract":"MedTech" OR "Author Keywords":"health*" OR "Author Keywords":"medic*" OR "Author Keywords":"MedTech"))

Algorithm-A X-13 Part III - Complete Search Expression in ACM DIGITAL LIBRARY using the address - https://dl.acm.org/search/advanced

All fields:

("SupTech" OR "Supervisory Technology" OR "RegTech" OR "Regulatory Technology") AND ("health*" OR "medic*" OR "MedTech")

Algorithm-A X-14 Part III - Complete Search Expression in GOOGLE SCHOLAR using the address - https://scholar.google.ca

e:RegTech OR intitle:"Regulatory Technology") AND (intitle:health OR intitle:medical OR intitle:medicine OR intitle:MedTech)

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