Goal-Oriented Compliance with Multiple Regulations

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***Abstract*—Most systems and business processes in organizations need to comply with more than one law or regulation. Different regulations can partially overlap (e.g., one can be more detailed than the other) or even conflict with each other. In addition, one regulation can permit an action whereas the same action in another regulation might be mandatory or forbidden. In each of these cases, an organization needs to take different strategies. This paper presents an approach to handle different situations when comparing and attempting to comply with multiple regulations as part of a goal-oriented modeling framework named LEGAL-URN. This framework helps organizations find suitable trade-offs and priorities when complying with multiple regulations while at the same time trying to meet their own business objectives. The approach is illustrated with a case study involving a Canadian health care organization that must comply with four laws related to privacy, quality of care, freedom of information, and care consent.**

***Index Terms*—Legal Compliance, Multiple Regulations, Conflict Management, Goal-oriented Requirements Language**

I. Introduction

With the increase in the usage of cloud-based systems, the ability to access data and software from nearly everywhere, as well as the emergence of complex networked systems (such as banks imposing their regulations on their data center service providers), organizations and software developers are bound to comply simultaneously with many more regulations from different jurisdictions and domains. Complying with multi-national regulations introduces more complexity for business analysts, software and requirements engineers. These different regulations can enforce the same rules or have some overlap (e.g., one can be more detailed than the other). They can even conflict with each other. Also, one regulation can permit one to perform an action whereas the same action in another regulation might be an obligation or an interdiction. Thus, organizations and software developers must ensure that their products and services are compliant with all relevant regulations in order to avoid the high costs associated with non-compliance (e.g., financial penalties, delays in making a service or product available, reputation loss, and even imprisonment).

In previous work [9][12], we proposed a model-based framework called LEGAL-URN based on the User Requirements Notation (URN) [22] for modeling legal requirements in the same notation as organizational requirements. We extended the Goal-oriented Requirement Language (GRL), which is part of URN, to capture the main objectives and the structure of legal requirements. This extension, called Legal-GRL [11], is used to describe the goal model of the law/regulation, which is then linked to the plain GRL model of the organization (capturing its business objectives) [9]. To analyze the compliance of organizational GRL to Legal-GRL, the intentional elements in organizational GRL are linked to their corresponding elements in Legal-GRL. With the help of analysis algorithms [10], the compliance of the organization to the law/regulation is assessed. However, the framework discussed in [9] and in [12] only focuses on one regulation. In order to allow organizations to become compliant with more than one regulation, we extend the framework LEGAL-URN [12] to capture more than one regulation, analyze the challenges in handling multiple regulations, and identify solutions for handling them. We propose a pairwise comparison algorithm that defines the steps needed to compare two legal statements. We identify 5 cases that can occur while handling multiple regulations, and propose solutions on how to establish links between multiple regulations themselves as well as with the organizational GRL model.

In Section II, we present the related work while in Section III, we explain the LEGAL-URN framework together with two of its main layers. In Section IV, we define the steps needed for comparing regulations, and we provide an extension to the meta-model discussed in [11]. In Section V, we describe the pairwise comparison of each pair of statements and provide solutions for modeling them. We provide a case study from Ontario regulations in Section VI. We discuss the threats to validity and analyze the method in Section VII. Finally, we conclude our paper and explain the future work in Section VIII.

II. Related Work

Handling multiple regulations, being compliant with more than one regulation at the same time, and resolving conflicts between multiple regulations are challenging activities for both researchers and organizations. In the last few decades, much work has been done to resolve conflicts in software requirements [1][7][8][28][31]. However, up to now, very little work has been done to address these issues for the legal requirements domain.

Maxwell et al. [25] are amongst the first to provide a set of techniques to help requirements engineers identify, analyze and resolve conflicts in multiple regulations. Their work identifies four patterns for internal and external cross-references. The main focus of their research is on two of the patterns, which are (i) external cross-references and (ii) internal cross-references that point to other portions of the legal text. With respect to

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these patterns, a legal cross-reference taxonomy is developed with six categories. This taxonomy is used to identify the type of conflicts caused by cross-references and to provide a set of heuristics for the resolution of conflicts [31]. Although this work provides some grounds for identifying different cases when comparing multiple regulations, it mainly focuses on the conflicts caused by cross-references and not on comparing multiple regulations. This work only deals with textual requirements and not more abstract goal models of regulations.

Gordon et al. [15][16][17] introduced a framework that uses requirements watermarking and the requirements specification language (RSL) to (i) put high-level and low-level watermark standards across multiple regulations, (ii) translate the regulations to a canonical form and a set of metrics [5], and (iii) rationalize and analyze the differences and similarities between statements. In the watermarking framework, the first step is to extract and encode requirements from the two regulations with the RSL methodology. The second step is to compare the specifications, identify similarities and differences and measure the differences. Finally, the last step is to generate watermarks by identifying union disjoint and minimum watermarks. The union reconciliation aims to merge requirements from multiple jurisdictions by analyzing the dissimilarities, identifying similar requirements between the two regulations, and merging the two near-equivalent requirements into one single requirement. In a minimum watermark, the requirements from one regulation that does not exist in the other regulation are omitted while in a disjoint watermark these requirements are preserved. These steps can be repeated for the third, fourth, and n^{th} regulations to capture all requirements in a single requirements set.

Siena et al. [29] focus on extending the *Nómos* Framework [30] to capture variability in laws. This work aims to capture the "antecedents" and "consequents" of clauses in the model of a law to analyze the "applicability" and "satisfiability" of these clauses to a set of requirements and evaluate their compliance. To analyze the compliance, the approach includes situations, roles and six types of relations. With respect to the relations and the norm parts, the authors provide forward and backward reasoning for compliance.

The related work presented in this section aims to analyze legal requirements and resolve conflicts or handle multiple statements. These approaches mainly focus on the conflict cases. In our work, we focus on broader situations while dealing with more than one regulation. We also provide solutions for modeling these cases and for establishing the links between these legal models and the organization within the LEGAL-URN framework [12]. We propose solutions for compliance between multiple regulations and organizations.

On the basis of a recent literature review [13], methods are provided to ease linking legal texts and requirements with a knowledge base managing representations of the laws, such as frame-based or description logic-based formalisms, as used by artificial intelligence approaches [3][24]. This is needed for addressing the problems of completeness when selecting laws concerning specific domain, including the hierarchy between regulations used for inconsistencies management [23]. For this latter problem, some support can be given by methods of the artificial intelligence using the legal interpretations of the laws [4]. Legal interpretation can be used as a feed for identifying different alternatives in goal and business models. In this context, LEGAL-URN can be the main method used for law modeling and analyses by domain experts and regulators. One of the strengths of our method is the tight relationship with artificial intelligence representation of knowledge about laws to reduce the gap between the specificities of legal texts and the requirements engineering models needed for analysis [3][14].

III. LEGAL-URN FRAMEWORK FOR COMPLIANCE

The LEGAL-URN framework [12] aims to support business process compliance with regulations. The LEGAL-URN has four layers for legal and organizational models:

- **Official Source Documents**: used to define the legislation on one side and organizational structures, policies and processes on the other side.
- **Hohfeldian Model**: consists of a set of Hohfeldian statements [32] together with structured elements of legal statements.
- **Legal and Organizational Goal Models**: based on URN's GRL, they capture the objectives and requirements of both organization and legislation.
- **Legal and Organizational Business Process Models**: based on URN's Use Case Maps (UCM) notation, they define the organizational business processes as well as representing steps mandated by legislation.

The LEGAL-URN framework supports five types of links between the layers of the models as well as between the legal and organizational parts: source, compliance, weighted/simple traceability, responsibility and consequence links [9].

This framework aims to model regulations in the same notation as organizational goals, objectives and business processes. However, some aspects of regulations are not easily captured by GRL or UCM. Thus, URN has been extended with a *Legal profile* to capture legal elements. The new extensions are called *Legal-GRL* and *Legal-UCM*.

To formalize the mapping between regulations and Legal-GRL, we introduce the Hohfeldian model layer, based on frames to capture the deontic and ontological aspects of legal texts. Here, we briefly discuss Hohfeldian and Legal-GRL models since the compliance analysis is done on the GRL level. More details about the framework are discussed in [12].

A. Hohfeldian Model of Regulations

The Hohfeldian model, which is an intermediate level between the legal text and the Legal-GRL model, uses Hohfeldian concepts for classifying legal statements, as well as legal statement structural elements such as *subject, modality, verb, actions, preconditions, exceptions* and *cross-references* (see the Hohfeldian model structure on the left part of the Figure 1 and in Figure 2). Like most frame-based methods that extract knowledge from texts, we identified the following rules:

- **Rule 1** – Each legal statement shall be atomic. This means that each legal statement contains one legal «actor» (the subject) and one «modal verb» (modality). The statement

can also have one to many legal «clause» («verb» and «actions»), 0 to many legal «cross-reference», 0 to many «precondition» and 0 to many «exception».

- **Rule 2** – If a legal statement contains more than one modal verb, it must be broken down into atomic statements.
- **Rule 3** – Legal exceptions must be also broken down into separate atomic legal (exception) statements.
- **Rule 4** – Preconditions must be linked to either a clause or an exception.
- **Rule 5** – When a precondition (*P*) for the clause (*C*) holds for the legal actor (*A*), the clause is obligatory (*Ob*). When a precondition (*P'*) for the exception (*Ex*) holds, the exception is obligatory (*Ob*).
- **Rule 6** – If there is an internal cross-reference, we replace the referencing part with the referenced statement and break the statement into atomic statements. External cross-references also break into atomic statements but they are mapped to the original legal statement via links.

Each Hohfeldian statement, based on Hohfeld's definitions, can be one of the following types: Duty-Claim, Privilege-Noclaim, Immunity-Disability, or Power-Liability. These statements are refined to permissions or obligations in the Legal-GRL level. The semantics of our Hohfeldian model is described with the GRL evaluation model [12] and with the help of dependency links. When a precondition in the Legal-GRL model is not triggered, it is annotated with a «no-precondition» tag and is removed from the analysis. Without considering the GRL evaluation method, this roughly corresponds to the following logic formulas:

$$((P \wedge \neg P') \implies C_{ob})$$

and

$$\big((\neg P \wedge P') \implies Ex_{ob}\big).$$

B. Legal-GRL Modeling for Regulations

In [11], we explain how to create a Legal-GRL model of regulations. For this, Hohfeldian statements are refined to *permission* and *obligation* (soft-) goals. To capture preconditions, exception and external cross-references, we introduce three other types of goals, also mapped to the Hohfeldian model: precondition goals/softgoals, exception goals/softgoals and XRef goals/softgoals. Figure 1 presents the mapping between the Hohfeldian and the Legal-GRL models.

HOHFELDIAN MODEL	LEGAL-GRL MODEL
SECTION	-
SUBJECT	ACTOR, EXPECTIONACTOR
MODAL VERB	OBLIGATION, PERMISSION STEREOTYPE
CLAUSE	INTENTIONAL ELEMENT
PRECONDITON	PRECONDITION INTENTIONAL ELEMENT
EXCEPTION	EXCEPTION INTENTIONAL ELEMENT
XREF	CROSSREFERENCE IE

Figure 1 – Mapping between Hohfeldian and Legal-GRL Models

IV. Comparison Analysis of Regulations

Comparing multiple regulations implies comparing pairs of statements from different regulations to determine whether they are independent, similar, complementary, or contradictory.

However, as each regulation can contain many statements, trying to analyze all possible pairs is not practical. This scalability issue can be mitigated by taking advantage of the structure of regulations. The legal text schema defined in [1], states that a law can have *books, chapters*, *parts, titles* and/or *sections*. Indeed, related statements are often clustered under one of these categories or various levels of sub-sections or sub-parts. Chapters and books can also contain sections. Parts can be used as an alternative to sections. By following these structures, it is possible to compare two legal statements which are categorized under the same book titles, chapters, sections or parts. In this paper, we focus on comparison based on section; however, if the regulation does not include a section, parts, chapters or books can be used alternatively.

By matching pairs of related sections (from two regulations) first, we can focus on pairs of statements coming from each section, and prune out the pairs that involve statements of a matched section and statements of unmatched sections. Such section-focused pairwise analysis can hence reduce the number of pairs to compare drastically.

To capture the *section* concept, we extend the Hohfeldian meta-model of [11]. Figure 2 shows the extended meta-model, which now includes one new meta-class (Section, with a name attribute). Note that, Section can be replaced by part, book, chapter, etc. Each Hohfeldian model is composed of 1 to many sections, and refers to possibly many statements. Each section can have 0 to many subsections and each section or subsection can have 0 to many Hohfeldian statements. The rest of the Hohfeldian meta-model remains the same.

Figure 3 presents an excerpt of a Hohfeldian model for Article 39(2) of the Freedom of Information and Protection of Privacy Act (FIPPA) [27]: *Notice to individual- Where personal information is collected on behalf of an institution, the head shall, unless notice is waived by the responsible minister, inform the individual to whom the information relates of [..].*

The pairwise comparison algorithm, shown in Figure 5 can then take advantage of this new data structure to classify matching pairs of regulation statements. Finding sections of a regulation that are relevant for the sections of another regulation requires manual effort from experts (e.g., lawyers). However, this can be done once for each pair of laws/regulations, so this effort can be amortized when this information is reused by multiple organizations. There are five cases considered in *compareStatements()*, and they are explained in Section V.

The comparison between two legal statements is done at the Hohfeldian model layer, i.e., two actors, two modal verbs, two clauses, etc. are compared to each other based on their natural language attributes. In the pairwise comparison, the synonyms of the natural language text of each element are considered by the expert (e.g., Lawyer).

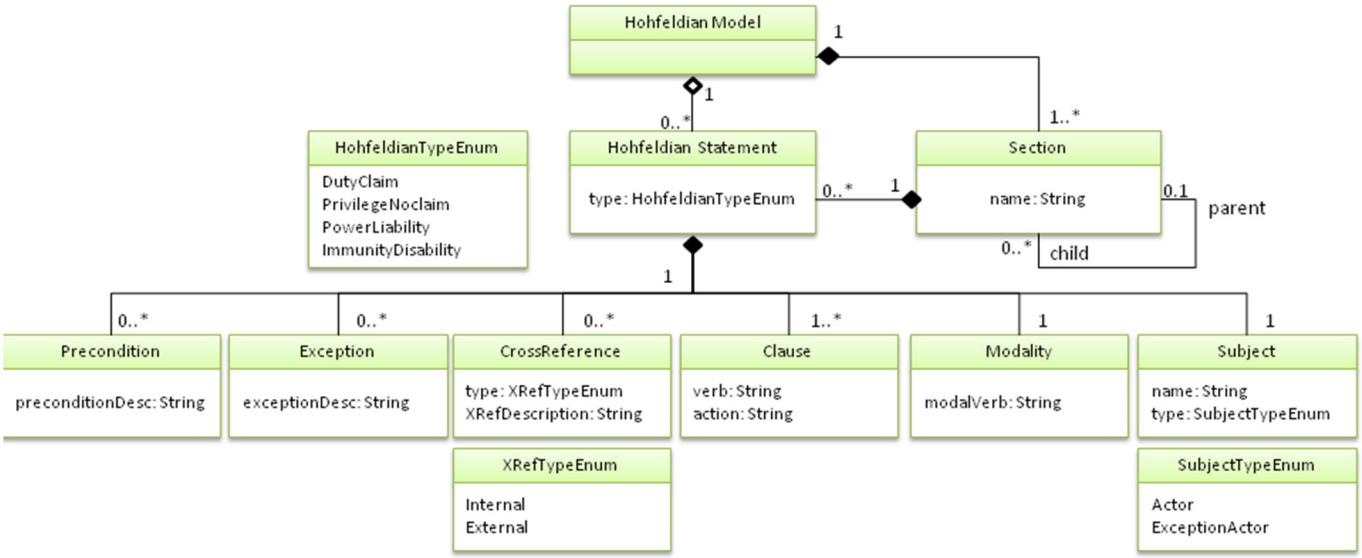

Figure 2 – Hohfeldian Meta-Model

SECTION	Notice to individual
ARTICLE#	FIPPA-39(2)
ACTOR	Head of institution
MODAL VERB	Shall
CLAUSE	Inform individual [..]
PRECONDITON	Where PI is collected on behalf of [..]
EXCEPTION	Notice is waived by responsible minister
XREF	-

Figure 3 – Hohfeldian Model of FIPPA 39(2)

To create the Legal-GRL model for multiple regulations we follow the steps below:

- Step 1. Identify relevant legal and organizational documents.
- Step 2. Develop a Hohfeldian model for each of the regulations identified in Step 1 by classifying each statement of the legal document based on Hohfeld's classes of rights [32] and identifying the Hohfeldian elements (i.e. actor, modal verb, clause, precondition, exception and cross-reference) defined in the Hohfeldian model layer, while linking them to the source legal document (via source links).
- Step 3. Develop the goal model of the law for each of the regulations and annotate the intentional elements with «Permission», «Obligation», «Precondition», «Exception», and «XRef» tags. Create source links to the legal documents, and compliance links to the Hohfeldian model.
- Step 4. Use the pairwise comparison algorithm (Figure 5) to classify the various cases, and establish traceability links between the legal models for cases 2 to 4 (see Section V). The traceability links between low-level tasks of the two models are *weighted* traceability links with contribution factors at 100 (on a scale that goes from -100 to +100). The *weighted* traceability links ensure that the satisfaction values of one legal model propagate to the other legal models connected to it. Between matching pairs of high-level goals or actors from the two legal models we find *simple* traceability links (correlation links with contribution factors at 0).
- Step 5. Develop the GRL model of organization and establish traceability links between Legal-GRL and GRL.

V. Pairwise Comparison of Two Statements

When dealing with more than one set of requirements documents and in our case more than one regulation (Step 4 in the previous section), the following cases involving two statements can be observed:

- Case 1 - There is nothing in common between the two statements.
- Case 2 - Both statements are similar to each other.
- Case 3 - One statement is complementary to the other statement.
- Case 3′ - One statement is a subset of the other statement.
- Case 4 - One statement is stricter than the other statement.
- Case 5 – One statement contradicts the other statement.

Based on the rule 1 in Section III, we define the structure shown in Figure 4 for $Statement_i$ and $Statement_j$.

The function compareStatement ($Statement_i$: HohfeldianStatement, $Statement_j$: HohfeldianStatement) from the algorithm shown in Figure 5, where $Statement_i$ comes from the first Hohfeldian model (hm1) and $Statement_j$ from the second model (hm2), is what is being defined in this section.

Each of the cases is discussed here. Note that «section»s of the statements are not compared as they have already been found to match by an *expert legal modeler*. In addition, cases 1, 2, and 5 are symmetric, but cases 3, 3′, and 4 are asymmetric and hence need to be checked in both directions.

$Statement_i$	$Statement_j$
A_i	A_j
Mv_i	MV_j
$\forall i\ C_i$	$\forall j\ C_j$
$\exists i\ P_i$	$\exists j\ P_j$
$\exists i\ Ex_i$	$\exists j\ Ex_j$
$\exists i\ XR_i$	$\exists j\ XR_j$

Figure 4 – Anatomy of $Statement_i$ and $Statement_j$

A. Case 1 - Nothing in Common between the Two Statements

$Statement_i$ is dealing with an issue different from $Statement_j$.

In this case, at least «actor» (i.e., a «subject» of type Actor) and/or the «clause» («verb» and «action») and/or «exception» parts of each statement are different from each other. «Precondition» leads to a «clause» or an «exception». They can be different or not and still case 1 will hold. If the «actor» are similar or one is the subset of the other actor, but the «clause» and/or «exception» are different then still case 1 is hold. However, «modal verb» and «XRef» are not necessarily different. Two statements can be directed to the same actor, have the same type of modality and be related to the same cross-referenced statement but have different concerns. Table 1, case 1 provides the summary of the pairwise comparison for this case.

$$\forall i,j: \Big(\big((Ai \cap Aj) = \phi \big) \vee \big((Ci \cap Cj) = \phi \big) \Big) \vee \Big(\big(\big((Ai \cap Aj) = \phi \big) \vee \big((Ci \cap Cj) = \phi \big) \wedge (Exi \cap Exj) = \phi \big) \Big)$$

In this case, to ensure the compliance with both of the regulations, it is necessary to model $Statement_j$ of hm2 as is, add it to the Legal-GRL model, and provide the necessary links to the organizational GRL model (Step 5). There is no link between the two Legal-GRL models.

For example, Article 22 of PHIPA [20] and Article 47 of the Health Care Consent Act (HCCA) [19] both deal with the concept of "incapacity".

Article 22 of PHIPA states: *Determination of incapacity - An HIC that determines the incapacity of an individual to consent to [..] of personal health information [..] shall do so in accordance with the requirements and restrictions, [..].*

Article 47 of HCCA states: *Incapacity - An evaluator shall, [..], provide to persons found by the evaluator to be incapable wrt admission to a care facility such information about the consequences of the findings as is specified in the guidelines.*

Article 22 of PHIPA discusses the "incapacity of an individual to consent" and the responsibility of the HIC with respect to it while Article 47 of HCCA talks about an "incapacity for treatment". The «clause» and «precondition» of these two articles are dealing with two different issues. To be compliant with both regulations, organization needs to have both statements included in the Legal-GRL model.

B. Case 2 - Both Statements are Similar to Each Other

$Statement_j$ of contains «actor» («subject»), «modal verb», «clause» («verb» and «action»), «precondition», «exception» and «XRef» similar to those of $Statement_i$. In short, $Statement_i \equiv Statement_j$.

In this case, compliance with one statement ensures compliance with the other statement. However, to avoid any potential non-compliance in the face of change, it is necessary to model both of the statements in Legal-GRL and use traceability links between the two Legal-GRL models. The satisfaction values from one Legal-GRL model is propagated to the other Legal-GRL model via traceability links.

For instance, Article 25, Transfer of request, in the Freedom of Information and Protection of Privacy (FIPPA) [27] and Article 18, Transfer of request, in Municipal Freedom of Information and Protection of Privacy Act (MFIPPA) [26] both state: *Where an institution receives a request for access to a record and the head considers that another institution has a greater interest in the record, the head may transfer the request and, if necessary, the record to the other institution, within fifteen days after the request is received, in which case the head transferring the request shall give written notice of the transfer to the person who made the request.*

As illustrated in Figure 6, these two articles are addressing the same issue and have the same actors, preconditions, modal verbs, and clauses (without any exceptions or cross-references). Therefore, having a link between them (to manage change) and a link between one of them and the organization model will be enough for ensuring the compliance.

C. Case 3- One Statement is Complementary to the Other Statement.

$Statement_j$ and $Statement_i$ have their «actor» in common or complementary. Both statements have at least one «clause», 0 to many «precondition»(s), «exception»(s) or «XRef»(s) in common but each statement has at least one «clause» and 0 to many «precondition»(s), «exception»(s) or «XRef»(s) in addition to the common parts . «Modal Verb» for both statements are not necessarily similar but they are also NOT contradicting with each other. Table 1 formalizes this case.

$$Statementi \cup Statementj = Statementi + Statementj - (Statementi \cap Statementj)$$

In this case, we model both statements in Legal-GRL models but only link one of the statements as well as the complementary part of the second statement to the organizational model (Step 5). Again, the part of the Legal-GRL models that are similar are connected to each other by traceability links.

Article 44 from FIPPA states: *Personal information banks - A head shall cause to be included in a personal information bank all personal information under the control of the institution that is organized or intended to be retrieved by the individual's name or by an identifying number, symbol or other particular assigned to the individual.*

Article 10 of The Privacy Act [6] states: *Personal information banks - The head of a government institution shall cause to be included in personal information banks all*

```
Algorithm PairWiseComparison
Input hohfeldianModels: list of HohfeldianModel
Output pairedStatements: set of <Integer, HohfeldianStatement, HohfeldianStatement>

hm1, hm2: HohfeldianModel                          // two models to compare
sectionSet: set of Section                         // set of sections
sectionHM1, sectionHM2: Section                    // two sections to compare
statementHM1, statementHM2: HohfeldianStatement    // two statements to compare
index1, index2: Integer                            // two indices

// compare all unique pairs of models
pairedStatements = ∅
index1 = 0
while index1 < hohfeldianModels.size()
{
    hm1 = hohfeldianModels.at(index1)
    index2 = index1 + 1 // avoids comparing previously checked pairs
    while index2 < hohfeldianModels.size()
    {
        for each sectionHM1 in hm1
        {
            // get, manually, the set of sections in hm2 that relate to sectionHM1
            sectionSet = sectionHM1.manualSectionMatchingIn(hm2)
            // compare the statements for pairs of relevant sections
            for each sectionHM2 in sectionSet
                for each statementHM1 in sectionHM1
                    for each statementHM2 in sectionHM2
                    {
                        // determine case (1 to 6) and document it.
                        case = compareStatements(statementHM1, statementHM2)
                        pairedStatements.add(case, statementHM1, statementHM2)
                    }
        }
    }
}

return pairedStatements
```

Figure 5 – Pairwise Comparison Algorithm

personal information under the control of the government institution that (a) has been used, is being used or is available for use for an administrative purpose; or (b) is organized or intended to be retrieved by the name of an individual or by an identifying number, symbol or other particular assigned to an individual.

Figure 7 presents the comparison between the two articles. Article 10(1-2) includes the same «actor» and «clause» as those in Article 44. However, Article 10(1-2) contains additional «precondition» and «exception» that Article 44 does not entail.

This article also includes an exception rule: Exception for *Library and Archives of Canada – (2) Subsection (1) does not apply in respect of personal information under the custody or control of the Library and Archives of Canada that has been transferred there by a government institution for historical or archival purposes.*

D. Case 3'- One Statement is a Subset of the Other Statement.

This case is the subset of case 3. In case 3, both statements could have additional clauses, precondition, exception or XRef, while in this case, one of them has an additional clause, precondition, exception or xref.

$(Statementi \cup Statementj = Statementj)$

or $(Statementi \cup Statementj = Statementi)$

$Statement_j$ includes «actor» similar $Statement_i$ or one «actor» is the generalization class of the other actor. In addition, $Statement_j$ has minimum the same «clause», «precondition», «exception» and «XRef» of $Statement_i$, with some additional «clause» and potentially additional «precondition», «exception» or «XRef». This means $Statement_j$ includes further rules. For example, $Statement_i$ could deal with the disclosure of PHI to hospital researchers whereas $Statement_j$ would deal with disclosure of PHI to hospital researchers as well as external researchers. The formalization in Table 1 is asymmetric; therefore the same verification must be done by swapping $Statement_j$ and $Statement_i$. «Modal Verb» attributes for both statements are not necessarily similar but they are also *not* contradicting each other.

Similar to the previous case, compliance with the superset statement is enough, though both statements need to be modeled and linked through traceability links.

Article 29 in PHIPA [19] states: *Requirement for consent - An HIC shall not collect, use or disclose PHI about an individual unless, (a) it has the individual's consent and the collection, use or disclosure, as the case may be, to the best of the custodian's knowledge, is necessary for a lawful purpose; or (b) the collection, use or disclosure, as the case may be, is permitted or required by this Act.*

HM	FIPPA -25	MFIPPA - 18
S	Transfer of Request	Transfer of Request
A	The Head	The Head
MV	May	May
C	Transfer the request[..] within 15 days after received	Transfer the request[..] within 15 days after received
P	Where institution receives	If institution receives
EX	-	-
XR	-	-

Figure 6 – Case 2 – Pairwise Comparison Example

HM	FIPPA -44	PRIVACY ACT - 10
S	Personal information banks	Personal information bank
A	A Head	The Head of the government
MV	Shall	Shall
C	Caused to be included in a PI bank all PI under control	Caused to be included in a PI bank all PI under control
P1	Is organized or intended to [..]	Is organized or intended to [..]
P2	-	Has been used, [..]
EX	-	Subsection 1 does not [..]
XR	-	-

Figure 7 – Case 3 – Pairwise Comparison Example

Article 41 (1) of FIPPA mentions: *An institution shall not use personal information in its custody or under its control except, an educational institution may use personal information in its alumni records and a hospital may use personal information in its records for the purpose of its own fundraising activities, if the personal information is reasonably necessary for the fundraising activities.*

Figure 8 shows the result of the comparison. The clause, exception and precondition of article 29 of PHIPA covers more detail than article 41 of FIPPA. Compliance with PHIPA leads to compliance with FIPPA too. However, to manage the potential changes, both of the statements are modeled in Legal-GRL and the links between them are established.

E. Case 4- One Statement is Stricter than the Other Statement.

$Statement_j$ provides stricter modality or clause than $Statement_i$. In this case, «modal verb» in $Statement_j$ indicates an obligation while in $Statement_i$ it indicates a permission, or the «clause» in $Statement_j$ is stricter (e.g., in terms of time) than the «clause» in $Statement_i$. The other parts in both statements remain similar (see Table 1). Note again that the same verification must be done by swapping $Statement_j$ and $Statement_i$. Note that, only one of the conditions for «modal verb» or «clause» needs to be satisfied.

In this case, it is only necessary to be compliant with the stricter statement, i.e., being compliant with $Statement_j$ implies compliance with $Statement_i$. However, it is also up to the organization to decide to be compliant with which regulation. If an organization decides to be compliant with the less strict statement, it will have the non-compliance consequences which are handled in the LEGAL-URN framework in [12].

Similar to case 2, to be able to manage changes, we model both of the statements in Legal-GRL and link the intentional elements and actors of both models to each other via traceability links.

Article 47(2) - Right of Correction of FIPPA states: *Every individual who is given access under subsection (1) to personal information is entitled to,(c) require that any person or body to whom the personal information has been disclosed within the year before the time a correction is requested or a statement of disagreement is required be notified of the correction or statement of disagreement.*

Article 12(2) of the Privacy Act [6] mentions: *Every individual who is given access under paragraph (1)(a) to personal information that has been used, is being used or is available for use for an administrative purpose is entitled to (c) require that any person or body to whom that information has been disclosed for use for an administrative purpose within two years prior to the time a correction is requested or a notation is required under this subsection in respect of that information (i) be notified of the correction or notation, and [...].*

These two articles are talking about the right of correction under the same condition. However, Article 12(2) gives more time for correction than Article 47(2) (hence, the latter is stricter than the former).

HM	FIPPA -41	PHIPA- 29
S	Use Personal information	Personal information bank
A	An Institution	An HIC
MV	Shall	Shall
C	Not used PI [..]	[Not] collect, use or disclose [..]
EX	May use	May collect, use or disclose
P1	It is necessary	Has consent and is necessary
P2	-	Collection, use, disclosure is permitted
XR	-	-

Figure 8 – Case 3' – Pairwise Comparison Example

F. Case 5- One Statement Contradicts the Other Statement.

$Statement_j$ is in conflict with $Statement_i$ when both statements have a common «actor» and an actor is the generalized form of the other actor and «modal verb» and «clause» of one statement is in contradiction with the «modal verb» and «clause» of the other statement. If «precondition»s or «exception»s of the statements are contradicting with each other, there will be a conflict case. «XRef» can also be contradictory but since the «XRef» statements are themselves, atomic statements, the similar pairwise comparison can happen between them too.

In this case, complying with the first statement results in non-compliance with the second statement, and vice versa. To resolve the conflict however, it is necessary to ask a subject matter expert (e.g., a lawyer, a legal consultant, or a policy analyst), and incorporate the solution into the Legal-GRL.

Article 12(1) of the Privacy Act states: *Right of access - every individual who is a Canadian citizen or a permanent resident within the meaning of [..] has a right to and shall, on request, be given access to (a) any personal information about the individual contained in a personal information bank; and (b) any other personal information about the individual under the control of a government institution wrt which the individual*

Table 1- Summary of the Pairwise Comparison

Statements	Case 1	Case 2	Case 3/3′	Case 4	Case 5
Actor (A)	$\exists i,j: A_i \cap A_j = \phi$	$A_i \equiv A_j$	$(A_i \equiv A_j) \vee (A_i \in A_j)$	$A_i \equiv A_j$	$A_i \equiv A_j$
Modal Verb (MV)	-	$MV_i \equiv MV_j$	-	$(MV_i \in Pr) \wedge (MV_i \in Ob)$	$MV_i \zeta MV_j$
Clause (C)	$\forall i,j: C_i \cap C_j = \phi$	$\forall i,j: C_i \equiv C_j$	$\forall i,j: (C_i \subseteq C_j) \vee (C_j \subseteq C_i)$	$\forall i,j: C_i \Longrightarrow C_j$	$\forall i,j: C_i \zeta C_j$
Precondition (P)	$\exists i,j: P_i \cap P_j = \phi$	$\exists i,j: P_i \equiv P_j$	$\exists i,j: (P_i \subseteq P_j) \vee (P_j \subseteq P_i)$	$\exists i,j: P_i \equiv P_j$	$\exists i,j: P_i \zeta P_j$
Exception (Ex)	$\exists i,j: Ex_i \cap Ex_j = \phi$	$\exists i,j: Ex_i \equiv Ex_j$	$\exists i,j: (Ex_i \subseteq Ex_j) \vee (Ex_j \subseteq Ex_i)$	$\exists i,j: Ex_i \equiv Ex_j$	$\exists i,j: Ex_i \zeta Ex_j$
XRef (XR)	-	$\exists i,j: XR_i \equiv XR_j$	$\exists i,j: (XR_i \subseteq XR_j) \vee (XR_i \subseteq XR_j)$	$\exists i,j: XR_i \equiv XR_j$	$\exists i,j: XR_i \zeta XR_j$

is able to provide sufficiently specific information on the location of the information as to render it reasonably retrievable by the government institution.

Article 9(1) of the Personal Information Protection and Electronic Documents Act (PIPEDA) [18] states: *When access prohibited - An organization shall not give an individual access to personal information if doing so would likely reveal personal information about a third party.*

Article 12(1) obliges organizations to give access to an individual (even if it has a precondition about the revealing of personal information about a third party) while Article 9(1) obliges organizations *not* to give access to an individual. These two articles are in contradiction with each other. To be able to resolve this conflict, it is necessary to get advice from a legal expert in order to decide whether the access to the personal information reveals the conflict or not. Based on the result of the consultation, it is possible to decide which one of these two Articles applies to the organization.

VI. Case Study

In our case study, we select four regulations: a) PHIPA, b) Quality of Care Information Protection Act, 2004 (QCIPA) [21], c) FIPPA and d) HCCA and six organizational business processes. From each of the regulations, few statements are chosen. Table 2 shows the number of statements selected from each of the regulations.

Table 2 – Number of Statements Selected

PHIPA	QCIPA	FIPPA	HCCA
11	3	4	2

We perform the pairwise comparison between PHIPA (our base regulation) and the three other regulations and identify the cases. The result of the comparison is shown in Table 3. As seen from the table, case 1 has the highest number in all of the three comparisons. If the pairwise comparison algorithm starts from finding and eliminating the conditions that case 1 applies, then the number of comparison for the rest of the regulations will decrease. This will help reducing the effort of the comparison. The result of the pairwise comparison was evaluated by two other researchers as well.

After the comparison is done, the Legal-GRL model for each of the legal statements is created. In case 1, the Legal-GRL models do not have any link to each other. In case 2 to 4, we connect parts of the Legal-GRL models which are in common between the two models via *traceability* links. In case 5, a subject matter expert such as a lawyer should intervene. In our case study, we identified that the QCIPA states in Article 2 that in the case of a conflict with other acts or regulations, this act prevails. Thus, for the three conflicting cases, we modeled QCIPA and linked them to the organizational GRL models.

Figure 9 presents the link between Article 41(1) of FIPPA with Article 29 of PHIPA in Legal-GRL. The pairwise comparison between the two article matches case 3′ (Figure 8).

Table 3 – Pairwise Comparison of PHIPA & 3 Regulations

Regulation	C.1	C.2	C.3	C.4	C.5
QCIPA	22	1	7	-	3
FIPPA	37	-	7	-	-
HCCA	21	1	-	-	-

In this case, the high-level goals of the two models are linked through *simple* traceability links and the low-level intentional elements in FIPPA are linked to the low-level intentional elements in PHIPA. As seen in this figure, PHIPA has more intentional elements than FIPPA, which was also identified through case 3′.

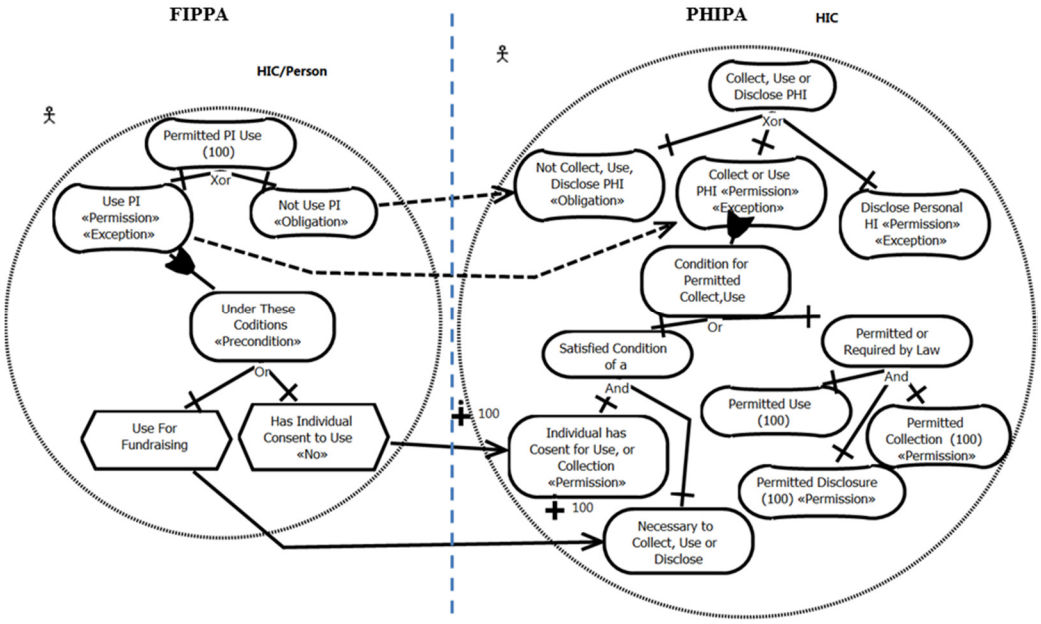

Figure 9 – Links between Legal-GRL Models of FIPPA and PHIPA

VII. Threats to Validity

In our study, we evaluated our algorithm for pairwise comparison by incremental construction of the case study. To mitigate the threats to construct validity, we first started by comparing the QCIPA with PHIPA, and defined the 6 pairwise comparison cases. Next, we added FIPPA to the model and compared it to PHIPA. Finally, the addition of the HCCA was the final demonstration of the appropriateness of the approach. We eliminated the pairwise comparison between QCIPA-FIPPA, QCIPA-HCCA and FIPPA-HCCA to reduce the size the case study. This elimination can be a threat to the validity of our compliance analysis result. We used our case studies from a real hospital in Ontario Canada, but, we never implemented the recommendations in the hospital. However, the models and the pairwise comparison analysis methods were reviewed and confirmed by two reviewers, one of whom is a URN expert. To mitigate internal validity threats, we aim to, first, semi-automate our pairwise comparison process through Cosine Similarity method used by an AI-based commercial tool, Eunomos [3], and then we will perform a usability study in a project in financial or telecom sector in Luxembourg. To mitigate threats to the external validity, we used four different regulations and six organizational business processes in our case study. This helped illustrate that our pairwise comparison algorithm and framework is not simply specific to comparing limited regulations and business processes. Although, we provided examples from other regulations while examining the cases, in our case study the regulations we used are all regulations that exist in Ontario and that are related to healthcare. We did not analyze our framework and our comparison algorithm in other domains. To mitigate this threat, we used the Hohfeldian ontology to build the Hohfeldian models, Legal-GRL models and covered as many cases as possible for comparison. The Hohfeldian ontology is a generic ontology for analyzing regulations and identifying different types of rights. Nevertheless, the framework needs to be validated outside the healthcare area.

VIII. Conclusion and Future Work

In this paper, we introduced a goal-oriented method for compliance with multiple regulations. We identified five cases for comparison of legal statements and provided solution on how to model them with Legal-GRL and link them to the organizational GRL models. We also established links between two Legal-GRL models to ensure the change management.

One of the constraints with goal modeling notations in general is the scalability issue, especially, when the number of elements in the models increases. We eliminate this problem by using and extending the eclipse-based tool support for URN, jUCMNav [1]. jUCMNav has the capability to create several models linked to each other through the same intentional element references. The satisfaction values for the intentional elements traverse from one model to the other via GRL analysis algorithms. These features of jUCMNav help avoiding having large, not scalable models.

In future work, we want to integrate our work with the Eunomos framework [3] [4]. Eunomos is a legal knowledge and document management system that focuses on identifying norms, cross-references and semantic similarities, with a clear structure for representing multiple interpretations and normative change. The Eunomos repository of law in legislative XML format can be integrated with the LEGAL-URN to help creating a semi-automatic method for developing Hohfeldian models. Eunomos generates a list of the most similar pieces of legislation in their database using Cosine Similarity methods. By reusing the Cosine Similarity method, we aim to identify the similar pieces of legislation at the legal statement or Hohfeldian Model level. By doing this integration, we can likely improve the comparison algorithm for multiple regulations and develop a semi-automatic algorithm.

Furthermore, we would like to improve GRL analysis algorithms to detect conflicts between the Legal-GRL models in the same way GRL performs for conflicting goals.

The comparison between regulations can also be done through the measurement of high-level goals of the regulation [28], which provide support for understanding the convergence and divergences between regulatory goals, and for resolving combined compliance problems.

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