

RESEARCH ARTICLE

An Ontological Method to Identify Simplification and Harmonization Opportunities in Legislation and Government User Interfaces

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ABSTRACT As part of its administrative duty, a government agency must translate written legislation to encode it in government information systems (GovIS) that operationalize the legislation. The research problem is that the complexity of the legislation and the GovIS could be masking misalignment. A misaligned GovIS could result in incorrect decisions for service consumers who may miss out on payments or services when they need them. This paper demonstrates a method to detect potential misalignment encoded in GovIS and to identify candidates for simplification and harmonization in the legislation to make it easier for auditors, government agencies, and service consumers to detect potential misalignment. The Design Science Research (DSR) methodology is applied to evaluate the GovUI-Onto method in three settings. The as-written legislative definition of an individual ‘*Australian resident*’ is compared to its translation in Government User Interfaces (GovUI), such as government service claim forms in the Welfare, Taxation, and Immigration settings. The research finds that GovUI-Onto is an effective method to detect encoded misalignment and identify opportunities for simpler and harmonized legislation.

INDEX TERMS Design science research, government user interfaces, GovUI-Onto method, harmonization, legislation, METHONTOLOGY, ontology, simplification, Terminae.

I. INTRODUCTION

This paper reports on Information Systems research concerning the use and implications of information technologies that operationalize legislation in organizations [1]. If an Information System (IS) is the application of people, technologies, and processes used to solve business problems [2], then a Government Information System (GovIS) must be a system that applies people, technologies, and processes to government problems. The research reported in this paper applies an exaptation design science research (DSR) methodology to assure service consumers that Government Information Systems (GovIS) maintain the integrity of the written legislation.

Government agencies administering government programs are accountable to Parliament and must assure its Audit Committee that GovIS aligns with legislation. Misalignment

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with legislation may suggest that government agencies collect too much or too little information to provide the necessary services. Misalignment can lead to delays or mistakes in decision-making. In welfare situations, this means that some of the most vulnerable members of our society may not receive the services they require when needed.

The research reported requires access to the legislation and the GovIS. In Australia, the legislation is freely available through government websites. The research uses a Government User Interface (GovUI) as a window into the GovIS. Accessing the GovIS requires authorization to government backend systems and the skills to understand and query them. A GovUI, such as a government claim form (paper or online), captures information from service consumers applying for government services. This information is the data that is used in the GovIS to determine eligibility.

The developer is responsible for implementing legislation in artifacts such as application forms, guidance material such as Taxation rulings, etc. Still, the complex and closed GovIS

system means that only auditors with access and knowledge can review and interrogate these systems. An auditor's assurance should validate that an agency is asking a service consumer a question to fulfill a requirement in the legislation. An auditor may conduct a cursory comparison of the GovUI to the legislation and determine that there is a requirement to collect citizenship information from a service consumer. However, this is a superficial alignment, and a deeper inspection of the legislation is required to ensure that the information requested in a GovUI meets a legislative requirement. To continue with the example that the legislation requires that an individual is a citizen, in a pre-implementation scenario, the developer could use the term 'citizen' in the GovUI to collect information about citizenship date and type from a service consumer. Post-implementation, an auditor might carry out a simple check that an Agency is collecting information from individuals that may be related to being a citizen. The problem with this method is that it results in a superficial match. *Prima facie*, a service consumer's information may appear related to citizenship, but it may not be. This paper will demonstrate how this relationship requires a closer examination using an ontological approach to confirm that the written law requires the information requested in a GovUI from a service consumer.

An auditor can avoid making superficial and inaccurate conclusions by comparing each legislative requirement in the written legislation to an implementation in a GovUI. If they find misalignment, this suggests that the operationalization of the GovUI needs further investigation.

The research reported in this paper also describes some instances where similar concepts are not the same. For instance, the definition of an individual 'Australian Resident' has different meanings in the Welfare, Taxation, and Immigration settings. A harmonization exercise may determine that they need not be different. If they are required to be different, simplifying them may provide a more effortless and transparent implementation in GovIS.

This paper uses the GovUI-Onto [3] definitions to detect misalignment and identify legislative simplification and harmonization opportunities. Simpler legislation will help to unmask misalignment masked by complexity.

The Human-Computer Interaction (HCI) discipline reports on the design of forms, screen layouts, and content in some depth. A similar study presented by Patrick and Kenny compares privacy legislation to the HCI requirements to design an interface design solution [4]. This research differs because it does not design a GovUI interface to implement the legislation. Instead, it is observing a GovUI implementing it.

The GovUI-Onto is a manual method purposefully designed to avoid introducing further complexity that may mask misalignment. Unlike computer science research, this research does not attempt to develop or use a computer system to unmask misalignment, as this could further mask misalignment. This paper contributes an empirical study of the legislation and GovUI that utilizes documents in the

public domain, thus avoiding the requirement for an auditor with special access to complex and closed backend GovIS, which can be applied to examine individual legislation and develop a Whole government view in other jurisdictions and government settings. The research provides an investigation to identify significant alignment issues for Governments implementing complex legislation. The GovUI-Onto method makes the ontological relationships between the classes in the legislation and the GovUI explicit and makes the misalignment residing in the GovIS discoverable. The research also provides a novel way to identify opportunities for simplification and harmonization of legislation using the implicit ontological connections shared between agencies and across government.

Furthermore, the research provides a method to determine the degree of misalignment in different government settings using publicly available data. Another research contribution is the Guide to the GovUI-Onto method, which provides detailed steps for using the Method. This research provides a new view of alignment.

The remainder of this paper demonstrates the application of the GovUI-Onto method in the three government settings and a whole Government view to identifying misalignment between the written legislation and its operationalization in the GovIS of the responsible administering Agency, as well as opportunities for simplification of the legislation. Part II explains the difference between an ontology and an ontological approach. Part III describes the exaptation research used in the reported research to integrate different ways of building a legal ontology in a new way to compare as-written legislation to a GovUI. Part IV applies the GovUI-Onto method. Part V identifies opportunities for harmonization of the legislation. Part VI describes how GovUI-Onto can be used to determine the regulatory burden to understand the impact of harmonization for government service consumers. Part VII applies GovUI-Onto to identify opportunities for regulatory harmonization of the same or similar concepts, such as individual 'Australian residents' with different definitions of Welfare, Taxation, and Immigration. Part VIII presents the misalignment statistics in the three settings. Part IX provides the findings, and Part X presents a conclusion.

II. RELATED WORK

There exists related work comparing the implementation of Public Policy [46], where the benefits of ontology development include facilitating knowledge sharing, collaboration, and decision-making among stakeholders, as well as improving the efficiency and effectiveness of policy implementation. This work seeks an ontological method to determine the alignment of the GovUI to the legislation. It indicates areas where simplification and harmonization of the legislation could improve the transparency of the legislation in the government information systems that implement that legislation. Other work compares two ontologies to determine the most appropriate representation of a domain [47].

At the same time, the research reported in this paper uses an ontological approach to determine the extent to which a GovUI has implemented the legislation. Similar literature describes the GovUI-Onto method in detail [3] and the use of GovUI-Onto to determine the regulatory burden of an individual Australian resident [5]. This paper aims to demonstrate a method to detect potential misalignment encoded in GovIS and to identify candidates for simplification and harmonization in the legislation to make it easier for auditors, government agencies, and service consumers to detect potential misalignment.

An ontology is an “explicit specification of a conceptualization” [6]. A community of individuals agrees to use this specification to describe the concepts and relations in a domain of interest [7]. Conceptual modeling formally describes aspects of the physical and social world around us for understanding and communication [8]. A conceptual model is an abstract and simplified representation of reality [9]. Specifying a domain as a model makes it possible to understand or analyze it [10], [11].

III. RESEARCH METHODOLOGY

This qualitative research uses a design science research (DSR) methodology to create and evaluate the IT artifact [12]. DSR is an accepted research paradigm [13]. In this research, the IT artifact is the GovUI-Onto method, an explicitly applicable solution to detecting misalignment of the legislation to the GovUI that is implementing it.

It is essential to distinguish between design science and design research. The DSR literature covers the design research issues of doing the academic design work and the meta-level of conducting the research [13]. The academic design work is the design science, the process undertaken to create standards for rigor applied to the construction and evaluation of the artifacts [14].

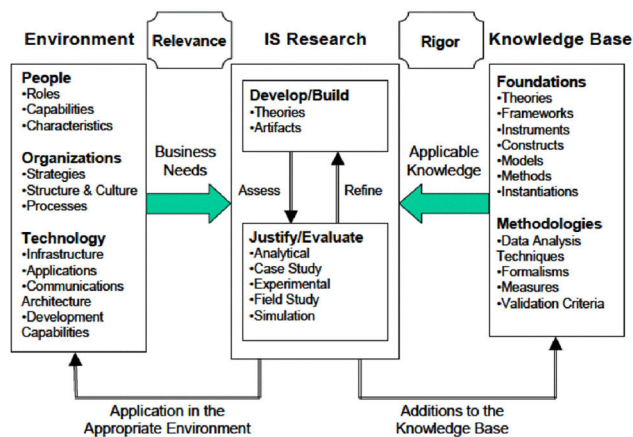


FIGURE 1. Information systems research framework [12].

The validity and value of design science as an IS research paradigm are demonstrated by DSR research [12], [15], [16]. The Information Systems Research Framework shown in Figure 1 is the overarching framework for conducting DSR.

The framework has three elements: Environment, IS research, and Knowledge base (depicted as three columns in Figure 1). The researcher conducts research in an Environment and draws on Applicable knowledge. The research should be relevant, i.e., addressing some ‘business need.’ The researcher should apply rigor, i.e., draw from recognized foundations and methodologies in the literature to answer the research questions. The researcher applies the knowledge base to the research environment and would then be able to reflect on how the research has added or contributed to the knowledge base.

There are four knowledge contributions in IS literature [17]. The first improvement is the development of new solutions for known problems. The second is the invention of new solutions for new problems. The third is routine design by applying known solutions to known problems. The fourth contribution is where knowledge already existing in one field is extended or refined for use in some new application area, i.e., exaptation research [17].

The research does not offer solutions for agencies to correct misalignment but only seeks to detect it. Knowing that misalignment exists, it is up to agencies to remove the requirement from the GovUI if there is no legislative requirement or explain it if collected for other than legislative reasons.

The domain for this research is the definition of an individual ‘Australian resident.’ The research question is, ‘Can an ontologically based method be developed that is useful/effective in investigating alignment between legislation and government user interfaces?’ If misalignment is detected, then ‘What is the degree of misalignment?’

The GovUI-Onto method can be applied by other jurisdictions using legislation and GovUI appropriate to its application. Future research will engage the individual agencies and legislative drafters to confirm that the harmonization suggested in this paper is appropriate and will result in simplification.

The iterative build and evaluate phases of Design Science Research (DSR) determine the study’s scope and answer the research question in a government service delivery setting. The model in Figure 2 describes how the legislation provides legality for the government to offer the service. The responsibility for the legislation is assigned to a minister whose Department may operationalize the legislation using a GovUI that a service consumer uses to apply for the service. The research being reported investigates alignment and simplification opportunities between the legislation and the GovUI, depicted by the dashed line.

A justification for pursuing legal harmonization within Australia is the difficulties or uncertainties arising from regulatory inconsistencies among jurisdictions and unacceptable differences in impacts for individuals due to inconsistent treatment of the same action across jurisdictions [18]. The research used the ‘Australian resident’ concept across different government settings covering government

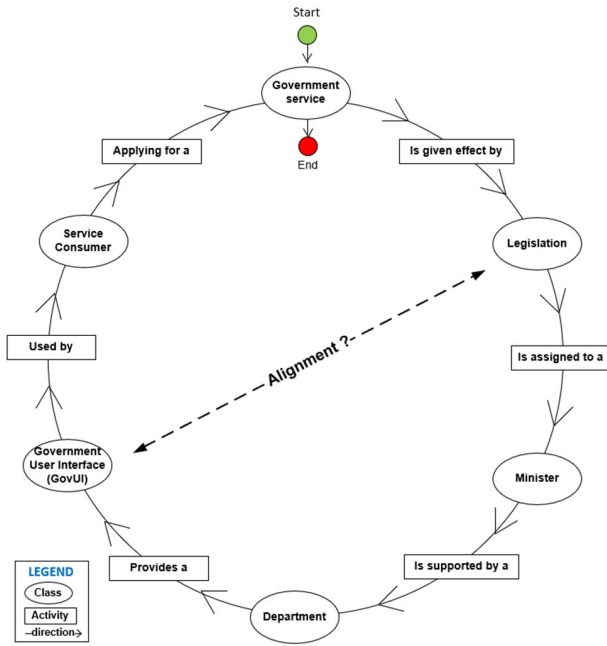


FIGURE 2. Research scope [3].

revenue (Taxation) and expenditure settings (Welfare and Immigration).

In Australia, the concept of ‘Australian resident’ has different legislative meanings in the public administration of Welfare, Taxation, and Immigration, and each of these three settings provides different benefits and obligations of an individual Australian resident, causing uncertainties for individuals. As explained below, an individual who satisfies the requirements for Welfare purposes will not automatically satisfy the requirements for Taxation or Immigration purposes. A question for the Government is, can one description define an Australian Resident in all three settings? A single definition would simplify the legislation for service consumers and government agencies.

IV. THE EXAPTATION

The GovUI-onto method is an exaptation of three methodologies. The first is METHONTOLOGY, a methodology used to guide the building of a specification of a domain ontology lifecycle [19]. The second is a methodology to build a legal ontology from scratch [20]. The third is Terminae [21], a methodology used to identify and compare relations between text concepts.

The research demonstrates how three methods designed for one purpose can be used (exapted) for new purposes. Gregor and Hevner discuss the exaptation of known solutions to new problems as one of the four types of DSR knowledge contributions [17]. Exaptation research is common in IS research and involves a researcher making interconnections and applying insights to expropriate theories and artifacts in one field to solve problems in a new field [17].

The knowledge being exapted adopts three methods for a new application area of detecting misalignment. The first method, METHONTOLOGY, describes a development cycle to build ontologies from scratch. METHONTOLOGY has been exapted to conceptualize the existing ontologies from the legislation and GovUI text. The second (Corcho) method is for building legal ontologies from scratch. The third method, Terminae, is used to build the hierarchy of concepts in a domain from texts [21], [22].

	METHONTOLOGY Fernandez et al., 2003	BUILDING LEGAL ONTOLOGIES Corcho et al., 2005	TERMINAE (Aussenac-Gilles et al., 2008)
Pre-development	Specification of ontology scope	Determine domain and scope of ontology	Domain resource (including corpus) gathering
Development	Conceptualization of the domain	Build a glossary of terms	Linguistic analysis
		Build concept taxonomies	
		Build ad-hoc binary relations	Conceptual modelling
		Build the concept dictionary	
		Describe ad-hoc binary relations	
		Describe the instance attributes	
		Describe the class attributes	
Describe constraints			
Describe formal axioms	Formalization		
Describe the rules			
Describe the instances			
	Formalization of the concepts and relationships as an ontology system		Formalization
	Implementation of ontology system		
Post-development	Maintenance of ontology system		

FIGURE 3. The exaptation of methods in Gov-UI onto.

Figure. 3 presents each of the three methods as a column, highlighting the parts of the methods applied to detect misalignment. Consideration of each of the three methods is covered in the next three sections. The application of the exapted method is provided in the fourth section that follows.

A. METHONTOLOGY TO BUILD AND ONTOLOGY FROM SCRATCH

A methodology to transfer IEEE 1074-2005, an engineering standard lifecycle process for developing a software project, to the process of building ontologies was created in the Artificial Intelligence Lab of the Technical University of Madrid called METHONTOLOGY [23]. The lifecycle has five stages for developing ontologies from scratch: specification, conceptualization, formalization, implementation, and maintenance.

- **Specification.** In this stage, the ontology developer must: articulate the purpose of the ontology and the intended users of the ontology; select the text; extract terms from the text; detect any synonyms; and extract the conceptual relationships [23].

- **Conceptualization.** In this stage, the ontology developer must structure the domain knowledge in a conceptual model. A glossary of terms found in the specification stage is an output of this stage.

- **Formalization stage.** In this stage, a frame-oriented or description logic representation system formalizes the conceptualization of the model [23].

- **Implementation.** This stage includes four phases: integration of existing ontologies, selection of the development environment, evaluation of the ontology, and documentation of the ontology.

- Integration of existing ontologies – In this phase, an ontologist should assess whether they could reuse existing ontologies [22]. Ontologies explicitly represent terms in a domain, and these representations are reusable. In this phase, the ontologist should explore opportunities to add an existing ontology to the new one. The ontologist can upload the representation of one or all terms to a new ontology for a new purpose.
- Selection of the development environment – In this phase, an ontologist should decide on an environment that supports the meta-ontology and ontologies selected at the integration phase. The result of this phase is the ontology codified in a formal language such as CLASSIC, BACK, LOOM, Ontolingua, Prolog, C++, or in your favorite language and so on [24].
- Evaluation - In the evaluation phase, an ontologist will make a technical judgment about the ontology, software environment, and documentation for a frame of reference (in this case, the requirements specification statement) during each phase and between phases of their life cycle. Evaluation subsumes the terms Verification and Validation [24].
- o Verification of the ontology guarantees the correctness of an ontology, its associated software environments, and documentation to a frame of reference during each phase and between phases of their life cycle [24].
- o Validation guarantees that the ontologies, software environment, and documentation correspond to the system they represent [24].
- o Documentation – In the documentation phase, an ontologist will record the design and implementation decisions used to build the ontology [24]. Throughout all stages of the lifecycle, an ontologist will make and take actions based on these decisions. Documenting these decisions is essential.
 - Maintenance. In this stage, the ontologist will manage changes to update and correct the ontology if needed [24].

Not all stages in the METHONTOLOGY lifecycle are required for the reported research because an ontology is not formalized or implemented. Only part of the conceptualization stage is required to build the conceptual model of the domain, but not entirely because it does not include the definitions of all the terms in the domain. See Table 1 for the full set of intermediate representations (IRs). The legislation does not define every term [25], and it is not the role of the researcher to develop a definition. Therefore, only a list of the terms is required. The research is building a representation of a domain limited to the definition of Australian Resident as it applies to an individual Australian resident in three different Acts.

B. METHODOLOGY TO BUILD A LEGAL ONTOLOGY FROM SCRATCH

A legal ontology is an explicit specification of a conceptualization in a legal domain. Researchers have used ontologies to represent legal sources and government services [26]. Researchers have used legal ontologies in the Netherlands

TABLE 1. Conceptualization activity according to methontology.

Tasks	Task title
1	Build glossary of terms
2	Build concept taxonomies
3	Build ad hoc binary relation diagrams
4	Build concept dictionary
5	Describe ad hoc binary relations
6	Describe instance attributes
7	Describe class attributes
8	Describe constants
9	Describe formal axioms
10	Describe rules
11	Describe instances

to describe Dutch unemployment benefits law and translate legislation into Tax and Customs Administration processes [27]. The reported research differs from this example because it investigates the GovUI, not the processes.

Corcho et al. 2005 presented similar research that applies the METHONTOLOGY methodology to develop an ontology in the legal domain [2018]. Ordinarily, the ontologist would undertake 11 intermediate representations (IR) (see Table 1) to document a conceptual model explicitly and totally for a legal ontology [20]. However, as no formalization is required, only three IRs are required: build a list of terms, build the concept taxonomy, and describe the class attributes.

C. THE TERMINAE METHOD TO DESCRIBE LEGISLATIVE CONCEPTS IN AN ONTOLOGY

Another methodology for building a legal ontology, the Terminae method, is used by ontologists to detect the terms that occur in texts and to describe these as concepts in a formal ontology [11], [23]. Also, ontologists have used the Terminae method to compare legislation ontologies to different texts in a complementary domain [27], [28] where the concept of Employee and Citizen occur in two European directives are merged in a formal ontology. Only the following steps that are to be used to explicitly document the conceptual model of selected ontological components found in the legislation and GovUI will be applied: determine the domain resource from the text; conduct a linguistic analysis to detect the concepts and relationships between the concepts in the text [29]; and finally, develop a model showing how the terms are related.

Figure 4 captures a clean version of the GovUI-Onto method in the Conceptualization stage of METHONTOLOGY, the three IR.s from the Corcho et al. 2005 method, and the three processes in the Terminae method that explicitly document the conceptual model of selected ontological components found in the legislation and GovUI [20].

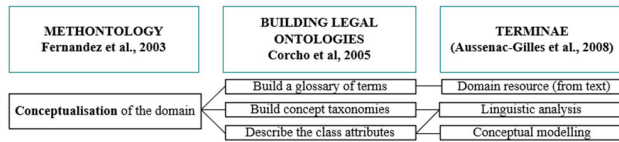


FIGURE 4. The exaptated methodology.

Future research will include other ontological components, such as definitions and axioms (rules); however, GovUI-onto limits the ontological components to Classes and the narrower relationship of Role classes, Role class attributes, and “Is_a” relationships as described in the following:

- A class is a set of entities [30]. A Role class is any role the legislation uses to describe an individual when determining whether they are an ‘Australian resident.’ A Role class is a sub-set of a class. For example, an individual could hold a Role class as an Employee or a Visa holder.
- A class attribute is a requirement derived from the text in the legislation or GovUI about an individual to determine if they are an ‘Australian resident.’ For example, the legislation may require an Australian resident to be Born in Australia.
- An ‘is_a’ class’ is an inheritance association describing a parent and child association between Role classes. For example, an individual may be a visa holder or, more specifically, a permanent visa holder.

The following excerpt from the legislation describes the ontological relationships used. An Australian Resident Class is a person who: resides in Australia and is an Australian citizen s7(2)(a)(i) Social Security Act, 1991 [31]. This excerpt provides three relations: the first is that an Australian resident is a person (i.e., an individual, and not a company, incorporated in Australia); the second is that the person has a Role class of Resident, and the third is that the person has a role of an Australian citizen. Does the excerpt also provide three Role class attributes, i.e., requirements about the individual Australian Resident where a Boolean Yes/No answer applies? Firstly, is the applicant an individual? Secondly, does the applicant reside in Australia? Thirdly, is the applicant an Australian citizen? This example shows how an ontologist can use Role classes and Role class attributes to conceptualize the individual Australian resident definition without a formalized ontology.

The research undertakes a non-semantic investigation, i.e., it does not define the concepts related to an individual Australian resident. Instead, it represents the sub-set of the relations with the definition in the legislation and its implementation in selected GovUI. The researcher evaluates the use of GovUI-Onto by using three legislative definitions for the same term but in different settings.

V. APPLYING THE GovUI-ONTO METHOD

The outcome of applying the GovUI-Onto method is a series of models that can compare the written legislation and its implementation in the GovUI. The similarities suggest opportunities for harmonization, while the differences may

provide suggestions to simplify the legislation. By modeling the Role classes related to an individual Australian resident in the written legislation, one can understand which roles require an individual applicant to be an Australian resident. Understanding the Role class attributes of an individual as provided in the legislation allows one to understand the regulatory burden placed on an individual to be deemed an Australian resident.

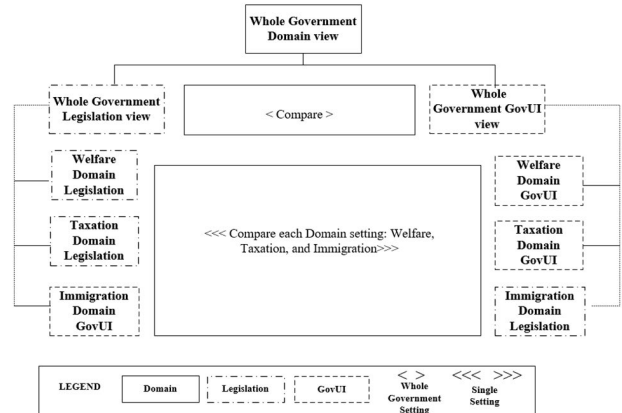


FIGURE 5. Bottom-up development identifies harmonization opportunities.

Figure 5 depicts the bottom-up approach used to detect the Attributes associated with Role Classes associated with an individual Australian resident from the legislation and GovUI. A bottom-up method involves identifying and studying the characteristics of base concepts and assembling them depending on their similar features that are then clubbed together to form a large concept until a root concept is reached [32]. Figure 5 starts at the bottom of the diagram. The attributes associated with an individual in the GovUI and the legislation in each setting are identified and compared. This approach allows the administering Agency to consider the written legislation and its operationalization in the GovUI.

While the different legislation means that the Role and Role class attributes should not be identical over the three settings, the similarities and differences allowed the researcher to make some interesting observations. For example, a government view can identify harmonization opportunities by merging and displaying unique instances. The researcher also compared the Class attributes models in the settings to understand an individual’s regulatory burden and identify any legislative simplification and harmonization opportunities.

Agencies will find that some legislation is more straightforward to translate into a GovUI than others. Table 2 lists a set of unique Role class attributes found in both the legislation and the GovUI of the Taxation setting. For example, one attribute of an individual Australian resident is that they are not a company, as provided in Table 2, line 1. An agency can implement this quickly by asking a binary question in the application form: Are you a company with options of Yes or No answers? However, implementing the legislation

TABLE 2. Taxation role class attributes (excerpt).

Unique Role Class Attribute	Aligned	Misalignment	
		In legislation but Missing from UI	Not in Legislation but Added by UI
Not A company	1		
Resides In Australia	1		
Domicile Is In Australia	1		
Comm Sat Perm Place Abode Outside Australia	1		
Been In Australia >1/2 Year Of Income	1		
Comm Sat Abode Outside Aus & Not Intend Aus Residence	1		
Member Scheme Superannuation Act 1990	1		
Eligible Employee Superannuation Act 1976	1		
Spouse Or Child Under 16 Of Person A o rB	1		
Behaviour In Aus Suggests Residing In Aus			1
Intention Or Purpose Of Presence Suggests Residing In Aus			1
Family And Business Employment Ties Suggests Residing In Aus			1
Maintenance And Location Of Assets Suggests Residing In Aus			1
Social And Living Arrangements Suggests Residing In Aus			1
Period Of Physical Presence In Aus Suggests Residing In Aus			1

when the requirement necessitates a qualitative assessment is more complicated. Consider instances where the legislation includes the word ‘suggests,’ as in the last six lines of Table 3. The legislation requires a decision maker to regard the nature and extent of the person’s accommodation, family relationships, employment, business or financial ties with Australia, and assets located in Australia. Asking an applicant where they live (accommodation), work (employment), their business (Australian Business Number), and bank (assets) may easily confirm these about a person.

TABLE 3. Whole government role class attributes (excerpt).

Line	Attributes of Applicant
1	Absent From Aus Part Period Not>12Months In The 4 Years Before Application Day
2	Not Present In Aus As An Unlawful Non Citizen At Any Time 4 Years Before
3	Australian Citizen
4	Country Of Citizenship Australia
5	Born In Australia
6	Country Of BirthAustralia

However, the legislation also requires that a decision maker consider ‘any other matter relevant to determining whether the person intends to remain permanently in Australia.’ In this case, a decision-maker may make decisions based on very different criteria than another decision-maker. The discretion provided in the legislation could have very different outcomes for a service consumer.

An agency may choose to address any identified anomalies in different ways. For example, the Agency may change the legislation to remove the discretion or propose a guidance material for decision-makers to ensure that there is some standard approach to the decision that will not disadvantage applicants. Alternatively, the Agency may accept the risk or make the discretion clear in the GovUI by providing a free-text field for an applicant to give some examples that they believe could demonstrate that they an individual is residing in Australia.

Table 3 describes examples of language issues. The table provides customized excerpts of the unique Role class attributes in the government view as a list for simplification.

The first pair (lines 1 and 2) are synonymous but have different labels, ‘Absent from Australia’ and ‘Not present in Australia.’ Similarly, the second pair (lines 3 and 4) asks if an individual is an ‘Australian Citizen’ or has a ‘Country of Citizenship, Australia.’ Lastly, the third pair asks if an individual is ‘Born in Australia’ or has a ‘Country of Birth in Australia.’

A lack of standard language creates confusion in labeling attributes or requirements. To facilitate the operationalization of the legislation, legislative drafters could simplify the requirements by ensuring that when an individual must possess an attribute, the requirement is a Boolean. For example, does the individual, company, or other in a Role, say a resident, a student, etc., possess an attribute? Yes or No?

VI. HARMONIZATION ACROSS THE GOVERNMENT

This section uses the GovUI-Onto method to understand two types of candidates for harmonization in the legislation and the GovUI. The first candidates exist in the language used to describe the attributes of individuals. The second is in the description of role classes.

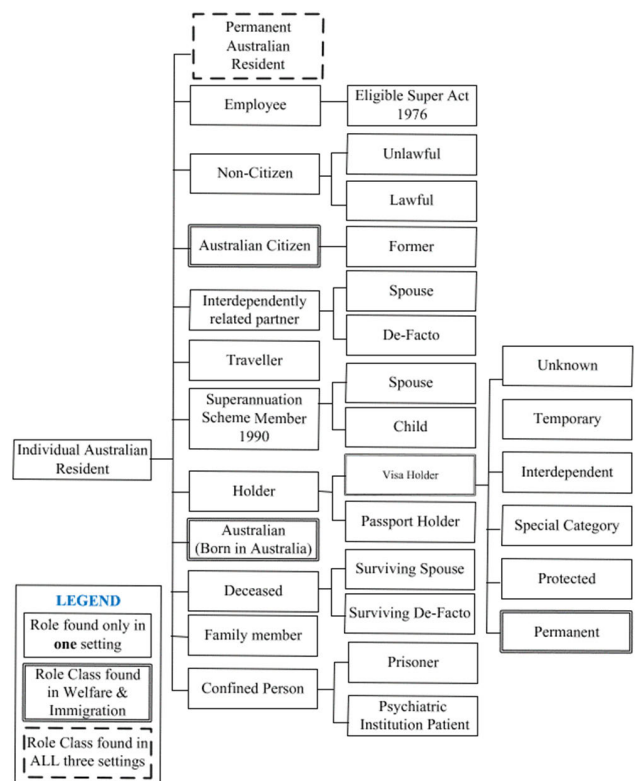


FIGURE 6. Role classes related to an individual Australian resident.

An Agency can also use the whole Government Class roles model to identify other harmonization opportunities. The model in Figure 6 depicts 32 unique Role classes associated with an individual Australian resident. Surprisingly, the individual Australian Resident has only one shared Role designated by the dashed borderline.

The model also shows some shared roles between the Welfare and the Immigration setting designated by a bold borderline, suggesting that Welfare and Immigration Agencies could work together on harmonization. At the same time, working with the Taxation agency may not be fruitful. Extending this ontological modeling to cover more legislation and GovUI will mean that more harmonization options may emerge. Legal harmonization facilitates interoperability [33]. With an extension to include other legislation and GovUI, a fuller and richer picture of the requirements imposed on an individual can emerge.

Similar research applies ontology mediation to determining and overcoming ontological differences [24] where the authors subdivide ontology mediation into three areas: ontology mapping, which is mainly concerned with the representation of correspondences between ontologies; ontology alignment, which is concerned with discovering correspondences between ontologies; and ontology merging, which is concerned with creating a single new ontology from source ontologies [34], [35]. The left pane of Figure 7 shows the differences between an ontology merge and ontology alignment. The former process is where a new ontology merges two original ontologies, O1 and O2 [left-hand side]). The latter process is where ontology alignment means that two ontologies persist [right-hand side], with the lines between them depicting the links between them [35].

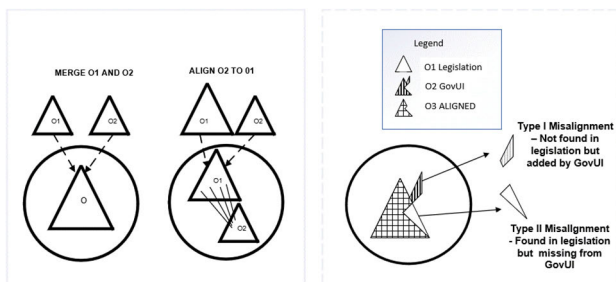


FIGURE 7. Ontology merging and alignment [27] and GovUI-Onto mis/alignment.

The GovUI-Onto method applies a different approach to identify misalignment. Firstly, the Method applies ontology alignment to model the ontological components, ontology mapping to identify similarities and differences between the models, and ontology merging to identify instances of alignment and misalignment.

Identifying the alignment and misalignment is required, rather than merging the ontological representations when answering the research question. Figure 6 accommodates the pinpointing of differences. The second pane in Figure 7 compares the ontological representations to identify two types of misalignments: Type I, where legislation ontological components are missing from the GovUI, and Type II, where the GovUI adds ontological components not in the written legislation [3].

VII. APPLICATION OF GovUI-ONTO TO DETERMINE REGULATORY BURDEN FOR INDIVIDUALS

This section states the findings from a previous paper on this research, which applied the GovUI-Onto method to quantify the regulatory burden imposed on service consumers being assessed as Australian residents by different agencies [5]. Figure 6 provides a whole Government view of the Roles associated with an Individual Australian resident.

The branches emanating from the cell called ‘individual Australian resident’ provide narrower terms (or has_child relationships) as represented in branches and represent all the possible Role classes in any of the three settings. For example, an individual might be a Holder, Employee, or Citizen, while an individual who is a Holder might hold a passport or a visa.

An Is_a relationship can identify the broader term (or has_parent relationship), such as a Permanent visa holder Is_a Holder. Understanding the number and types of different legislative roles an individual holds is helpful for Government agencies when considering cohorts of citizen interactions in a citizen-centric approach to service delivery.

Understanding the regulatory burden for government service consumers is only possible using a whole Government approach. Role classes in the legislation may have associated attributes. Some examples of Role Class attributes appear in Tables 2 and 3. The attributes of the Role classes provide implicit legislative rules that must be satisfied to meet the requirements of an individual Australian Resident. The researcher compared the Role class attributes to determine the relative burden on individuals seeking to demonstrate that they are Australian residents in each setting. The Welfare setting has 20 attributes, Immigration has 18, and Taxation has only 15.

The GovUI-Onto method allows the Government to develop a whole Government view to understanding the uncertainty for a service consumer straddling multiple settings. A harmonization exercise could reduce the inconsistencies that make the legislation difficult for individuals to understand, for agencies to implement and share, and for the Government to compare.

A. APPLICATION IN A WELFARE SETTING

This section presents the application of the GovUI-Onto method in the Welfare setting, where being an Australian resident entitles a person to apply for welfare benefits. The application describes the Role classes and Role class attributes related to an individual being assessed as an ‘Australian resident’ in the Welfare setting.

The example used to demonstrate GovUI-Onto is an ‘Australian resident’ for a Family Tax Benefit (FTB). The FTB is a payment to help families with the cost of raising children. The researcher compared the representations of three ontological relationships found in the legislation A New Tax System (Family Assistance) Act, 1999, [36] and the user interface, ‘Claim for an annual lump sum payment of Family Tax Benefit’ [37].

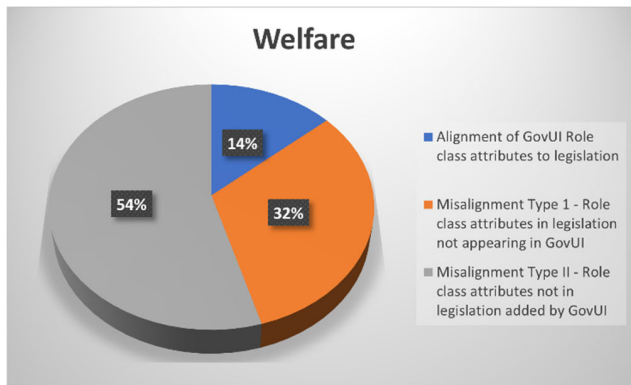


FIGURE 8. Welfare role class attributes % alignment and misalignment.

Overall, Figure 8 depicts 14% alignment and 86% misalignment (type I misalignment occurs because there are ontological components in the legislation that are not appearing in the GovUI (32%) + type II misalignment occurring because there are ontological components that are not in the legislation added by the GovUI (54%).

As an example of alignment, the legislation and the GovUI require an individual to be a Permanent Visa Holder. An example of misalignment resulting from a requirement in the legislation is ‘other matters suggesting the individual intends to remain permanently in Australia’. Still, there is no mention in the GovUI of these other matters. An example of misalignment resulting from the GovUI introducing a requirement to determine that an Individual has ‘Ever lived in Australia,’ but this is not mentioned in the legislation. The Social Security Act, 1997, section VII(2) provides that an Australian resident is a person who (a) resides in Australia. The corresponding section of the claim form called ‘Residence details’ includes ten questions. GovUI-onto method and undertaking an analysis of the ontological components provides a deep-dive into the understanding of alignment and unmask what the information system may be masking. Only by using the GovUI-onto method is doubt over the encoding of the requirement for an individual to disclose if they have ‘Ever lived in Australia.’

Without the type of GovUI-onto analysis, misalignment of the legislation and the GovUI is not apparent. The conceptual misalignment of 86% could suggest an ongoing systemic issue where the Government is asking service consumers for information that is not required, or it is not collecting enough information to make decisions about eligibility according to the written legislation.

B. APPLICATION IN A TAXATION SETTING

This section presents the application of the GovUI-onto method in the Taxation setting. The application describes the Role classes and Role class attributes related to an individual being assessed as an ‘Australian resident’ in the taxation setting, meaning the individual must pay tax in Australia.

So far, the researcher has applied the GovUI-onto to government application forms. In this application, the

GovUI is a taxation ruling the Commission of Taxation’s (the Commissioner’s) interpretative advice on Tax law as applied to a taxpayer or group of taxpayers’ circumstances [38]. In this application, the researcher compared the Tax Administration Act, of 1953 [39] and the income Taxation ruling (TR) residency status of individuals entering Australia. Figure 9 represents 87% alignment and 13% misalignment for the Taxation setting. Figure. 9 represents 87% alignment and 13% misalignment.

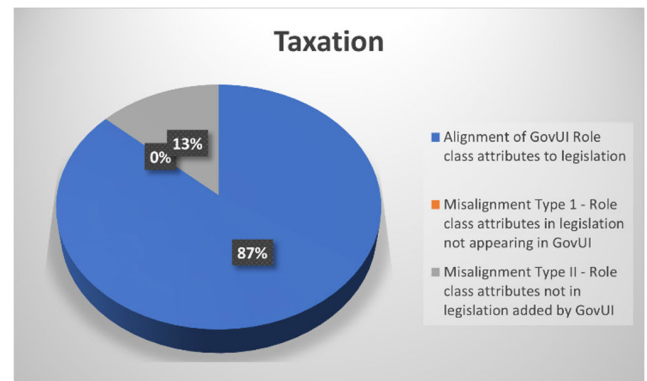


FIGURE 9. Welfare role class attributes % alignment and misalignment.

C. APPLICATION IN AN IMMIGRATION SETTING

This section presents the application of the GovUI-onto method in the Immigration setting. The application describes the Role classes and Role class attributes related to an individual being assessed as an ‘Australian resident’ in the Immigration setting, granting them Australian citizenship, and all the benefits it entails. In the Immigration application, the researcher compares the definition of Australian Resident in [40] the Citizenship Act, 2007, and sections of the application about an individual being an Australian resident [41]. Figure. 10 depicts the Role class attributes in the legislation and the GovUI is 100% aligned. The application form has applied the legislation verbatim (word for word). This alignment is shown in Figure 10 and is possible because, unlike the Welfare application, the legislative drafter has not introduced discretionary clauses that an Agency cannot translate in a GovUI.

D. A WHOLE GOVERNMENT SETTING

This section presents the fourth and final application of the GovUI-onto method, which combines the concept of ‘Australian resident’ in the Welfare, Taxation, and Immigration settings as a single view to study the alignment and misalignment of the concept of ‘Australian resident’ across the whole Government. This view enables the researcher to compare the degree of alignment and misalignment across the three settings, and it provides an example of a whole government view that a central agency can use to identify harmonization opportunities. The application is limited to three settings, demonstrating the potential of using the GovUI-onto method to understand alignment across the

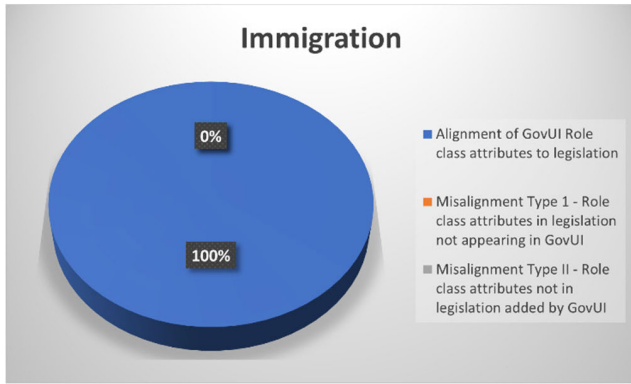


FIGURE 10. Immigration role class attributes % alignment and misalignment.

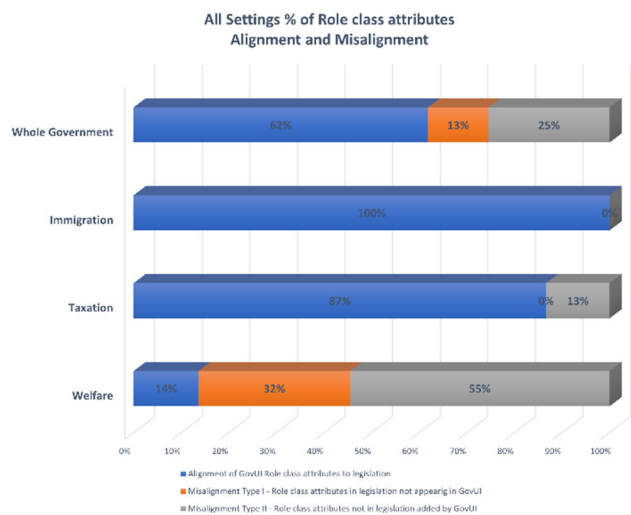


FIGURE 11. Whole government role class attributes % of alignment and misalignment.

Government. Figure 11 provides a whole Government view. Overall, the top horizontal bar graph shows that there is 62% alignment and 38% misalignment (type I misalignment occurs because there are ontological components in the legislation that are not appearing in the GovUI (13%) + type II misalignment, occurs because there are ontological components not in the legislation that agencies have added to the GovUI (25%).

VIII. MISALIGNMENT IN THE DIFFERENT ONTOLOGICAL COMPONENTS IN DIFFERENT SETTINGS

In addition to the pie charts identifying alignments and misalignments in the Welfare, Taxation, Immigration, and whole Government applications, the GovUI-Onto method has enabled the researcher to unmask misalignment. The research applies the GovUI-Onto method to the Welfare, Taxation, Immigration, and whole government settings. Notwithstanding, the whole Government setting only includes three settings, which supports the individual application studies' findings that GovUI-Onto can be used to compare alignment.

When comparing the whole Government alignment and misalignment of the three ontological components as in Figure 11: Role classes, Role class attributes, and Is_a relationships, the superficiality of assurance of alignment at the Role class level becomes clearer. Because Role classes are easy to identify in a GovUI, this is an easy alignment check with the legislation. See the horizontal Role classes bar in Figure 12.

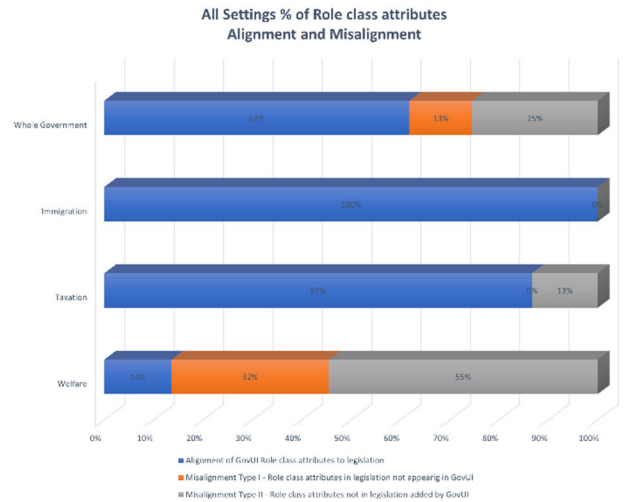


FIGURE 12. Whole government component alignment and misalignment.

If the analysis is limited to Role classes in the GovUI, then significant alignment would be the finding. However, a deeper examination of the horizontal bars of Role class attributes and Is_a relationships indicates sizeable misalignment.

As the Role class attributes represent the rules in the GovIS, this sub-set of ontological components may point to areas for further investigation to assure alignment.

IX. APPLICATION OF GovUI-ONTO TO IDENTIFY REGULATORY HARMONIZATION OPPORTUNITIES

A comprehensive representation can provide the Government with information to simplify and harmonize the legislation. While the Australian Law Reform Commission has announced the review of the Legislative Framework for Corporations and Financial Services Regulation, including the consistent use of terminology to reflect the same or similar concepts simplifying Australia's corporations and financial services legislation [42]. But there is no similar call to simplify it for constituents assuming individual roles, including Australian residents, parents, aged care, and welfare recipients.

In its Terms of Reference, the Financial Services Legislation: Interim Report B (ALRC Report 139), the Australian Law Reform Commission called for consistent terminology to reflect the same or similar concepts [42]. The individual 'Australian resident' concept exemplifies where constituents should expect consistency.

The research indicates that harmonization potential exists in this small study that examines one definition across three settings. A whole Government view facilitates the activity of simplifying and harmonizing the legislation. Figure 13 shows the number of shared components between the agencies across the whole government. Knowing where synergies do and do not exist could also be helpful in an exercise to determine interoperability opportunities. Using the GovUI-Onto Method, shared ontological relationships indicate the points of existing synergy.

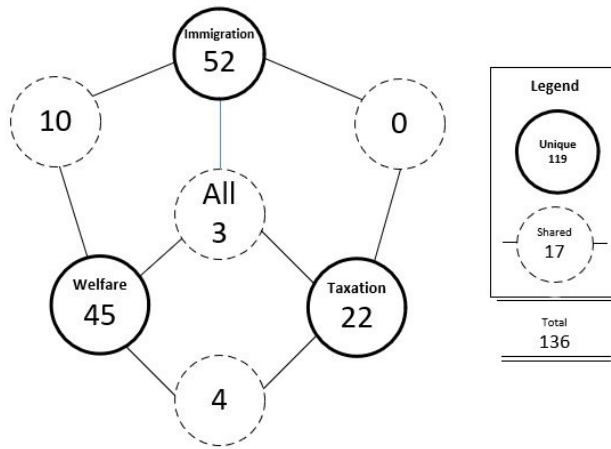


FIGURE 13. Whole government components shared / unique.

Figure 13 is a GovUI-Onto model identifying existing synergies. It represents the sharing of 17 ontological components. The bold circles represent the three settings as named, and the number in these bold circles is the total number of unique ontological components in that setting. The dashed circles represent the shared ontological components. The dashed center circle shows that the Welfare, Taxation, and Immigration settings share three ontological components: the Role class, Australian Resident, and two “is_a” relationships related to a Permanent Australian Resident, who must be a Person.

Figure 13 also indicates that there is some synergy between Welfare and Immigration (10 instances), less synergy between Welfare and Taxation (4 instances), even less synergy across Government (3 instances), and no synergy between Immigration and Taxation. Of course, the research only looks at the definition of an individual ‘Australian resident’ in three settings. Still, this information provides another way to identify the legislation connections across the government.

Ten ontological components are shared: Welfare and Immigration (4 role classes relating to Australian Citizens born in Australia and Visa Holders who are protected); four by Welfare and Taxation (An Australian citizen born in Australia, Family relationship that suggests a person is residing in Australia, Other matters that suggest a person is residing in Australia and an Individual who resides in Australia), and there is no sharing between Immigration and

Taxation. Sharing components occurs between Welfare and Immigration, but more evidence of synergies is required before agencies consider harmonization opportunities.

Unique instance numbers include Immigration at 52, Welfare at 45, and Taxation at 22. Welfare has 18 unique Is_a relationships, 17 Role class attributes, and 10 Role Classes. Immigration has the highest number of 21 unique Is_a relationships, 17 Role class attributes, and 14 Role classes. Taxation has 12 unique Class attributes, 6 unique Role classes, and 4 Is_a relationships.

Figure 9 presents the Government Role class attribute analysis identifying Role class attributes shared by and unique to different administering departments. Knowing the shared and unique attributes across the whole Government can inform other harmonization activities.

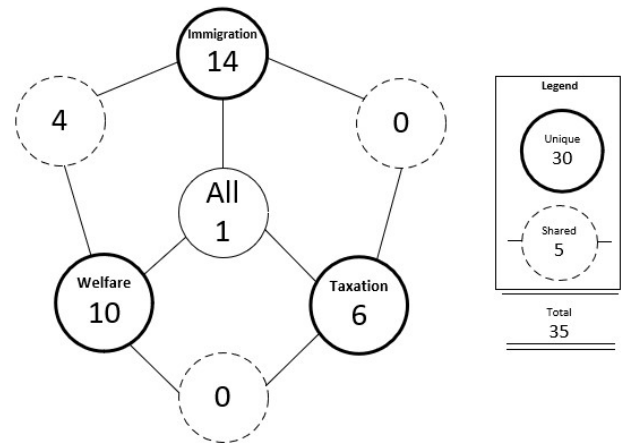


FIGURE 14. Shared and unique role classes.

The whole Government is extensible and can include more settings. Figure 14 summarizes categorizing 35 Role Class attributes across Welfare, Taxation, and Immigration settings as shared or unique. All settings share a single Role class attribute, four by Welfare and Immigration and Welfare and Taxation. Knowing the shared and unique attributes across the whole Government can inform the scope and order of harmonization activities.

The one Class role shared by all three settings is Australian Resident. Perhaps not surprising as it is the focus of the research. While Welfare and Immigration share 4 Class roles (Australian-born in Australia, Australian Citizen, Visa Holder, and Protected Visa Holder), there is a sharing of concepts between Welfare and Taxation.

The unique patterns show a concentration of information about Visa holders for Welfare, Superannuation Scheme Members under the Superannuation Act for Taxation, and Partners, Non-citizens, and Confined Persons in the Immigration setting. These demonstrate the unique nature of responsibility for those functions in the Government.

The GovUI-Onto method has identified ontological relationships between Classes, Role classes, and the Role hierarchies related to the concept of an individual Australian Resident. Furthermore, the shared and unique ontological

components help understand existing synergies created by the legislation. Identifying these synergies provides a novel way to understand interoperability opportunities.

X. EVALUATION

The GovUI-Onto Method was evaluated using the Information Systems Research Framework shown in Figure 1. The evaluation compared the ontological relationships in the legislation to the GovUI in each setting. Firstly, in the Welfare setting, the Taxation setting (using a Tax ruling instead of a government claim form), and the Immigration setting. The researcher also developed and evaluated the use of the GovUI-Onto method in a Whole Government setting and made some observations about harmonization opportunities reported in this paper.

The researcher ran a validation exercise with metadata experts to confirm that some written instructions to detect classes, Role classes, and Role class attributes from a small legislation section were clear. The results helped to improve the information provided to people learning to use the GovUI-Onto method. The validation exercise may be requested by emailing the researcher.

XI. THE FINDINGS

Instances of misalignment may indicate that an agency is collecting too much or too little information. Too much information suggests privacy issues, while too little requires prospective consumers to provide additional information to enable the Government to determine their eligibility for limited government services. Another concern is where decisions determining eligibility occur without the necessary data.

The research provides a method to identify both misalignment and alignment. Applying GovUI-Onto can assure agencies that the operationalized GovIS aligns with the written legislation. While the whole Government application includes three settings, it supports the findings that agencies can use the GovUI-Onto method to compare alignment misalignment in the user interfaces that implement the legislation. The study found 63% misalignment in Welfare, 24% in Taxation, and 32% in Immigration. The cross-setting misalignment is 41%.

The whole Government view suggests significant alignment in the Role classes 68%, while misalignment is most notable in the attributes of the classes 45% and the Is_a relationships 46%. In summary, the burden on an individual varies across the settings. Welfare burdens an individual with 22 requirements, while Immigration imposes 18, and Taxation imposes 15. The information provided in this paper indicates the differences in three settings in the same jurisdiction that determine whether an individual is an Australian resident. The Government could consider standardizing the requirements for applicants.

Future research will extend the ontological components to include definitions and rules [20]. Also, future research will engage the administering departments to determine how

many misalignments can be explained by the requirement for administrative purposes.

XII. CONCLUSION

The significant contribution of the reported research is the development and application of the GovUI-Onto method to identify potential misalignment in GovUI. This paper has contributed working examples using current legislation and actual GovUI to understand alignment. Service consumer representative groups can use the Onto-GovUI method to compare the regulatory burden for individuals in different settings. Designers in government agencies can use the same method to identify opportunities to reduce the complexity of legislation and GovUI.

Ontology engineering is a labor-intensive and knowledge-intensive task [43] requiring human processing. This paper provides an example where full automation is still impossible [44]. This thinking remains consistent with best-practice software testing when manual testing remains necessary, especially for highly complex and context-dependent alignments [45].

This paper has demonstrated using the GovUI-Onto method to identify misalignment and inconsistent regulatory burden placed on individuals being assessed as Australian residents in different settings in the same jurisdiction. By representing three ontological components in the GovUI and legislation and comparing them, it finds different levels of requirements for individual Australian residents in different settings. This paper has also demonstrated the use of the GovUI-Onto method in harmonization activities and has provided semantic examples to simplify the legislation. GovUI-Onto is an exaptation of other methods for a new purpose in different jurisdictions. The GovUI-Onto method provides auditors with a method to assure audit committees and service consumers that government information systems are implementing the written legislation, and it also provides agencies, researchers, and other external groups the ability to assure themselves of such alignments without requiring access to complex and closed backend systems.

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