Towards Legal Interoperability in International Data Spaces

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Abstract: The value of data exchange is indubitably a thriving approach, however, it must be conducted in a safe and sovereign space, avoiding the loss of control, and data misusage. The International Data Spaces (IDS) is supposed to be a trusted environment, in which companies could share sensitive data upholding data sovereignty. Thus, mitigating the risk of losing industrial secrets and further threats to competition. Along with the mentioned two foundations of IDS, its architecture allows a free contract endorsement, on which, companies may negotiate their policies and governing laws. A service contract should be able to unambiguously represent all involved policies, leaving no breach for subjectivity. Another important aspect of IDS is to follow the Findable, Accessible, Interoperable, and Reusable (FAIR) principles. In particular, we focus on the Legal Interoperability. As one of the proposed layers of interoperability (intended by the European Interoperability Framework), Legal Interoperability is proposed as the capability of companies from different countries (under different governing laws) to cooperate. This paper provides a research agenda and presents prior results of the proposed methodologies, addressing how to resolve legal interoperability issues before establishing IDS legal agreements. It takes a Design Science perspective for problem decomposition into specific issues, triangulation of research methods, and projection of a solution space.

1 INTRODUCTION

Companies nowadays try to keep the balance between sharing data among business partners to optimize operations and controlling it for competitiveness and integrity. This reality leads to a discussion about *data sovereignty* - individuals' and companies' ability or power to control who and how one could use their private data (Otto, 2019). There have been initiatives to enforce data sovereignty in the corporate domain. For instance, an *Industrial* Data Space has been proposed as an environment where companies could share sensitive data based on mutual trust assumptions (Otto et al., 2019). As business ecosystems evolve, sharing corporate data may cross international boundaries, which motivated the proposition of *International* Data Spaces (IDS) – an environment where companies could share data based on competence legitimized by certifications and explicit data usage policies – as defined by the International Data Spaces Association (IDSA)[1]. The IDS Reference Architecture Model (RAM) and implementation guidelines proposed by IDSA are aligned with the European Interoperability Framework (EIF) [2]. The EIF proposes the division of interoperability into six operational layers, the foundational ones (GANCK, 2017), i.e., Legal, Organizational, Semantical, and Technical interoperability, and the recently added, i.e., Interoperability Governance and Integrated public service governance.

As for the scope of our research, we are complying with the foundational layers, responsible for grounding the IDS RAM [3]. For instance, in an IDS-based business ecosystem, a data usage policy formalizes technical aspects of data exchange (e.g., data formats, standards, and transformations) (Ganzha et al., 2017); data brokers may rely on ontologies to describe, discover, and select data connectors suitable to the needs of data owners or data users (Firdausy et al., 2022a), or enterprise architectures may guide

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[2]https://ec.europa.eu/isa2/eif_en/
[3]https://internationaldataspaces.org/offers/reference-architecture/

the development of processes and services to leverage Enterprise Interoperability (Firdausy et al., 2022b). However, little attention has been paid to enforcing or promoting legal interoperability in IDS. For instance, the IDSA Dataspace Protocol[4] specifies schemas and protocols required from entities to publish data and negotiate data usage policy agreements. However, it lacks explicit guidance on enforcing legal restrictions and compliance in an IDS-based business ecosystem. Moreover, in a multi-organizational scenario different legal norms may impact how actors exchange data in the IDS-based business ecosystem, and data may face interoperability barriers, such as different schemas, different protocols, different descriptions, and subjective representations (Chituc et al., 2009).

This paper provides a research agenda to address *how to promote the legal interoperability necessary to unambiguously represent contract policies in a machine-readable way, fostering its automatization*. We adopt Design Science (Wieringa, 2009) as a guiding research methodology to decompose this problem into minor ones, identify research methods (Sandberg and Alvesson, 2010) necessary to treat it, and project a solution space of design artifacts. To accomplish the Design Science problem investigation phase, we propose the General Research Question 'How to achieve legal interoperability in IDS?', which is further decomposed into conceptual, technical, and practical issues. The treatment design phase of the methodology shall comprehend the development of a Systematic Literature Review (SLR), focusing on knowledge questions, and the development of software artifacts, among which, is an ontology for legal interoperability in IDS, and further machine learning model development for automatic instantiation and classification of proposed legal aspects. The validation phase of the design cycle will demand a combination of methods, including, a case study evaluation, and a focus discussion group.

The rest of the paper is organized according to the following: **Section 2** presents a set of supporting arguments, leading to the motivation of this research. **Section 3** applies the first step of Design Science Research, defining the problem, with further decomposition into minor issues. Furthermore, **Section 4** defines the study goals, whereas summarizing the chosen methodologies to tackle the problems. **Section 5** presents the prior results of the presented methodologies, with an explanatory approach for each technique, finally, a discussion is presented. Lastly, **Section 6** encompasses the conclusion, analyzing the mentioned results, and expressing the current status of development and integration, with a final disclosure pointing towards future works and the next steps of the research agenda.

2 RESEARCH MOTIVATION

Not only responsible for managing, maintaining, and certifying the IDS initiative, IDSA is also involved in several types of research, as seen in (Otto et al., 2019)(Otto et al., 2022), and the main architecture such as the Reference Architecture Model (RAM), and Information Model (IM). International Data Spaces are designed to facilitate data exchange and data linkage in a trusted, protected, reliable, and standardized business ecosystem. The two main aspects of an IDS are data sovereignty and trust. The IDS initiative proposes a reference architecture model for data sovereignty and related aspects, including secure and trusted data exchange in business ecosystems. With numerous data spaces in Europe as well as in China, the Americas, and beyond, an authentic international phenomenon, and these spaces must be trusted to create value from data. Hence, there is a recurrent urge to develop a protocol with international validity.

Although Catena-X [5] and European Health Data Space (Stellmach et al., 2022) are good examples of large data spaces, there are smaller data spaces that only exist for fewer days, and with a smaller number of actors. Similarly, data spaces may be centralized, based on an organization or government body, or decentralized, adhering to a common rulebook but not bound by a central association. The proposed protocol should encompass a minimal viable interoperability approach for all the different frameworks, products, or services. Even though IDSA is currently developing the Dataspace Protocol, the legal aspects subject are addressed by a so-called Task Force Legal (Gras, 2023). Despite the legal approach being developed, there is still a lack of protocols and frameworks to work as a foundation, leading to repetitive and resource-intensive processes for each data exchange agreement.

Projects such as the Eclipse Dataspace Components[6] aim at providing frameworks that could act as a valid reference for third parties, enabling products and services built on top of the framework automatically to implement the Dataspace correctly, thus, being compatible with others using the same protocol. The IDS itself holds two contract samples, which

[4]https://docs.internationaldataspaces.org/dataspace-protocol/

[5]https://catena-x.net/en/

[6]https://projects.eclipse.org/projects/technology.edc

represent (based on German law), a data purchase contract, and a data rent contract. Those contracts work as an example for companies to provide their own contracts, referred to as 'contract freedom', by (Duisberg, 2022). However, this lack of standards leads to time and resource-intensive negotiations, due to contract subjectiveness and ambiguous interpretations. Further, (Duisberg, 2022) also states the development of the so-called legal test bed [7], which would be able to perform contract negotiation automation. However, it is still a future work. Finally, (Munoz-Arcentales et al., 2019) and (Weichhart et al., 2016) propose as future work the specification of a policy specification language, which is theoretically addressed by IDSA in the Usage Policy Specification [8], but not implemented in the Information Model.

Still, there is no current real application and validation regarding the legal interoperability layer. Through this work, we start a road map towards the development of semi-automated strategies to enhance the data exchange negotiation among countries.

3 PROBLEM DEFINITION

Design Science is a methodology to treat problems of practical relevance, which are normally complex (Wieringa, 2014), (vom Brocke et al., 2020). (Wieringa, 2009) proposes decomposing a main research question into conceptual, technical, and practical questions for traceability and assessment. Conceptual questions seek knowledge about real-world phenomena without interfering with or changing their internal state, whereas technical questions concern state-of-the-art technology to solve a problem. Finally, practical questions relate to how a software artifact could impact stakeholders' needs. This research agenda aims to treat the following general question:

General Research Question (GRQ): *How to Achieve Legal Interoperability in IDS?*

Assumptions: We follow the guidelines of the European Interoperability Framework, which sets legal interoperability as a top-level layer of Enterprise Interoperability, i.e., above the organizational, semantical, and technical layers. Treating Enterprise Interoperability issues with a bottom-up approach is possible in this context (and mostly preferred by current research). Still, we plan to follow a top-down approach, starting with the legal interoperability layer. Further, for the scope of this paper, we are addressing the four fundamental legal layers, once the recently added two address public integration, which is not supported by the Reference Architecture Model for now.

Problem Decomposition: The main research question splits into three other major questions, which are explained as follows.

General Conceptual Question (GCQ): *What is legal interoperability in Dataspaces?*

Assumptions: Data owners and users in an IDS-based ecosystem may operate under distinct governing laws for data sharing in different countries. Although the main goal of the proposed research regards Legal Interoperability specifically for IDS, we might as well examine the current literature in related dataspaces (once IDS technology is the foundation for different types of dataspaces).

Problem Decomposition: *(1) What is the current representation of service contracts in IDS? (2) How do legal aspects interfere with Data Sovereignty? (3) How are the legal norms and usage policies currently represented in IDS? (4) What are the legal moments/positions of IDS participants? Is personal-data management approached in IDS architecture?*

General Technical Question(GTQ): *How to effectively enforce Legal Interoperability in IDS?*

Assumptions: Resolving legal interoperability issues in an environment such as an IDS-based business ecosystem will ultimately involve human negotiation, especially with legal aspects, due to its subjectivity. By semi-automatic enforcement, we mean to promote legal interoperability in design time (interoperable by design).

Problem decomposition: *(1) Which machine-readable specification language could address policy representation? (2) How to enforce a common understanding of contractual bindings (policies)? (3) What constitutes the workflow of data exchange within IDS? (4) What is the current state-of-the-art regarding contract automation? (5) how could an application help resolve legal interoperability issues as a prelude to a contractual agreement?*

General Practical Question(GPQ): *How does Proper Legal Interoperability affect IDS-based ecosystems?*

Assumptions: Achieving a contractual agreement in IDS is a time-consuming and onerous process. Companies should be able to fulfill a proper negotiation and agreement, with a common understanding of the parties while endorsing data sovereignty and trust. The IDS architecture provides the possibility of dynamization in contract creation, the proposed dataspace may foster a mean understanding of the governing laws, or the instauration of a new one.

Problem Decomposition: *(1) How could a semi-automated approach facilitate the contract/policies*

[7] https://legaltestbed.org/en/start/

[8] https://docs.internationaldataspaces.org/ids-knowledgebase/v/ids-g/UsageControl/Contract

negotiation? (2) What is the common understanding potential of an ontology? (3) What implementations could reduce costs and time towards contract negotiation? (4) What is the impact of establishing the legal availability of participants, to foster the choice or creation of governing law?

4 Study Goals and Methodology

In Design Science Research (DSR) methodology, (Wieringa, 2009) defines the possible goals of research as social context goals (External stakeholders' goals and Context improvement goals) and the design science research goals, divided into Artifact Design Goal: to design or redesign an artifact, Instrument Design Goal: to design or redesign a research instrument, Knowledge Goal: to answer knowledge questions, and Prediction Goals: to predict future events. The present paper encloses the following goals:

Prediction goal: The prediction goal is not directly applicable to this research, however, the future implementation of proposed machine learning models may reach, at some level, the capability of inferring predictions.

Knowledge goal: Identify the ongoing gaps, challenges, and opportunities in the literature regarding the legal interoperability layer when applied to IDS. The knowledge goal is directly aligned with the SLR, answering knowledge (and conceptual) questions.

Artifact Design goal: Develop an expandable and acceptable legal interoperability protocol for data exchange negotiation among countries grounded by different data exchange policies, allowing the unambiguous representation of policies that compose a service contract. As a work in progress, we might move toward the implementation of the proposed ontology, in a Retrieval Augmented Generation (RAG) model, that encompasses the legal interoperability nuances of IDS and leverages the automation of processes regarding contract automation.

Instrument Design goal: Develop an ontology following the FAIR data principles (Guizzardi, 2020), which works as a legal base for further application development (ontology-driven development (Pan et al., 2012)). The ontology should leverage legal interoperability, therefore unambiguously representing the legal aspects domain regarding contract formulation, negotiation, and agreement. To do so, we are grounded by the Systematic Approach to Build Ontologies (SABiO) methodology, which defines a five-step (i.e., purpose identification and requirements elicitation, ontology capture and formalization, design, implementation, and testing) iterative guide for developing ontologies. The first and second steps are responsible for creating a so-called reference ontology, which graphically represents the ontology, and may be designed with languages such as OntoUML [9]. The design and implementation steps foster the development of the operational ontology, which is the most common approach in ontology engineering (Keet, 2018), ending up with an OWL/RDF operational ontology. The last phase is summarized as testing, but it also comprises its verification, completeness, and validation with stakeholders. Another Important approach of DSR is the clear eliciting of requirements. Requirements may be addressed as functional requirements and non-functional requirements. (Suárez-Figueroa et al., 2009) defines the Ontology Requirements Specification Document (ORSD), as a clear statement of why the ontology is being built, for whom, what the intended uses are, and especially, listing the requirements. As an ongoing work, the latest version of the proposed ORSD is available on an open GitHub Repository [10], along with the latest version of the reference ontology. Furthermore, we propose as future works the development of a machine learning model that enables the automatic and continuous instantiation of the ontology, and a Natural Language Processing (NLP) engine able to classify text snippets into the correct class, based on the ontology.

To answer the proposed RQs and foster the next step of DSR, i.e., treatment design, which comprises the specification of requirements, possible contributions to goals, available treatments, and design of new treatments, we focused on the following research methodologies: Review of literature, which, according to (Snyder, 2019), is the ability to rely on existing valid work, being the foundation of all academic research activity. For this particular research methodology, we proposed a Systematic Literature Review, which is fairly described in Section 5; Ontology Engineering, in Agreement with (Keet, 2018), plays a critical role regarding the machine-understandable web, and domain representation. Several other methodologies are encompassed, such as Formal Conceptual Analysis (Stumme, 2002), Prototyping (Luqi and Steigerwald, 1992), Completeness Test (Tambassi, 2021), and others. As for the last step of DSR (i.e., treatment validation), we propose the following methodologies: Case Study, defined by (Feagin et al., 2016) as an in-depth, multifaceted investigation. It allows the resemblance of the theoretical models applied to real-world scenarios; Finally, the Focus Discussion Group method, de-

[9] https://ontouml.org/

[10] https://github.com/VictorBenoiston/legal_interoperability_IDS_ontology

scribed by (Sutton and Arnold, 2013), is a possible solution for the limited theoretical understanding of proposed technology-driven research. Addressing those methodologies in the present work, it is possible to summarize the following methodologies:

Literature Review: *A systematic literature review for comprehending the legal aspects, gaps, challenges, opportunities, and future works encompassed in Legal Interoperability regarding IDS. The proposed SLR is based on the (Kitchenham, 2004) guidelines Furthermore, the retrieved aspects and papers may be used as a database for future implementation of machine learning models, and RAGs.*

Ontology Engineering: *As proposed by (de Almeida Falbo, 2014), formulate a reference ontology, encompassing the domain of the legal aspects regarding legal interoperability, relying on foundational ontologies such as Unified Foundational Ontology (UFO)(Guizzardi et al., 2022), Information Model (IM) (Bad,), and Service Contract Ontology (SCO) (Griffo et al., 2021). The ontology should answer open questions spotted on the SLR, and fulfill the requirements established by the stakeholders, and literature as well. Furthermore, the ontology should be enhanced to an operational version in OWL/RDF, in order to allow further implementation in applications, and machine learning models.*

Case Study: *In-depth understanding of the results, challenges elicitation, and validation in a real-life application scenario.*

Focus Discussion Group: *Validate the research with specialists, point out strengths and weaknesses, and present future works.*

Therefore, we may encapsulate our research goals, questions, and solutions road map as follows in Figure 1. Please note that, although we establish a possible prediction goal, it should be further addressed as the work proceeds, and it is not addressed in our proposed road map.

5 Prior Results and Discussion

To better understand the current challenges, opportunities, gaps, and proposed future work toward legal interoperability within IDS, and grounded by the first proposed methodology, we performed a Systematic Literature Review. 40 papers have been reviewed, from ACM Digital Library, EI Compendex, IEEE, ScienceDirect, Scopus, and SpringerLink databases. Figure 2. showcases the lifecycle of the proposed SLR. Along with an in-depth discussion of the legal aspects of IDS, the SLR presented 10 retrieved legal aspects that foster legal interoperability, i.e., domains

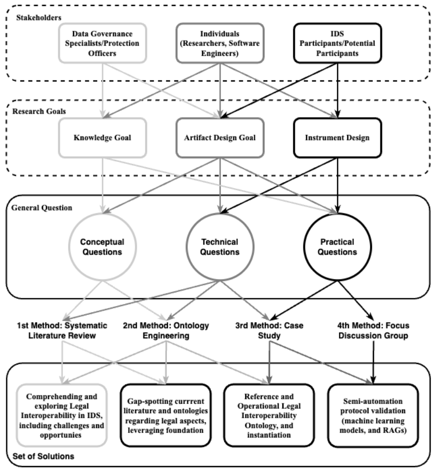

Figure 1: Problem-Solution set of the proposed work (Roadmap)

of business, personal / non-personal data, usage and data policies, interoperability constraints, smart contracts/contract automation, semantic appeal, AI usage in IDS, cloud, IDS usage in open spaces, and future works addressing legal aspects. Along with the retrieved legal aspects, the literature reviewed acknowledges 12 distinct kinds of future works, i.e., cloud, governance, AI, semantics implementation, technology integration, practical implementation, common understanding, privacy/personal data, modular templates, policy specification language, and automated negotiation.

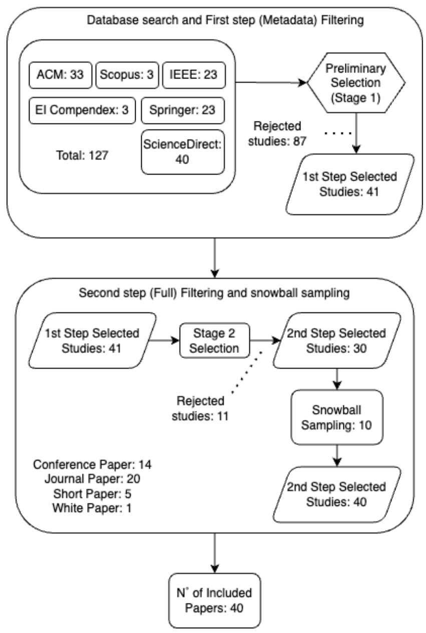

Figure 2: SLR Lifecycle

Outcome	Proposed Future Works	Level of Integration
SLR	Semantics Implementation (Reference and Operational), Common Understanding	High
Reference Ontology	Semantics Implementation (Reference), Common Understanding, Modular templates, Policy Specification Language	Medium
Operational Ontology	Semantics Implementation (Operational), Technology Integration, Common Understanding, Privacy/Personal Data, Modular Templates, Policy Specification Language, Automated negotiation	Medium
ML Classification Model	AI, Technology Integration, Modular Templates, Automated Negotiation	Low

Table 1: Alignment with Recovered Future Works and Current Level of Integration

Furthermore, part of the data retrieved on the SLR acted as a foundation for ontology development, especially the first and second steps of the SABiO (de Almeida Falbo, 2014) guideline (purpose identification and requirements elicitation and ontology capture and formalization). The SLR was able to ground the requirements for developing the reference ontology. The operational ontology was manually instantiated for testing and verification, also based on the retrieved data of the SLR.

For the operational Ontology, we provide a summary of the ontology metrics regarding the first version, provided by Protégé [11]. Protégé is a desktop/web tool designed by Stanford University to create and manipulate ontologies. The subset is available in Figure 3.

Metrics

Axiom	677
Logical axiom count	357
Declaration axioms count	254
Class count	73
Object property count	22
Data property count	24
Individual count	136
Annotation Property count	2

Class axioms

SubClassOf	74
EquivalentClasses	18
DisjointClasses	7
GCI count	0
Hidden GCI Count	4

Figure 3: Operational Ontology Metrics Summary

Thus far, based on the outcome of the proposed SLR, we might connect the intended future works with our road map of development. A few insights and metrics about the SLR were condensed in this GitHub Repository [12], along with its data. The latest version of the operational ontology is also available in the GitHub repository, as mentioned above.

6 Closing Thoughts

For this paper, we propose a DSR project, relate ongoing work, and state the roadmap towards its conclusion. Table 2 summarizes the proposed treatments (outcomes) of this DSR project, based on referring to proposed work highlighted by the SLR, and points out the current level of integration, i.e., *low* means a draft or a first version, *medium* refers to an ongoing work based on stakeholders' requirements, and *high*, alludes the final version of the outcome.

With 505 comma-separated values, collected from the SLR, the referred machine learning model is under development. The first version of the classification model can classify up to ten classes with a validation accuracy of 65%. The specifications of the proposed model are out of the scope of the presented paper, the latest version is available on the GitHub Repository [13]. We establish as future steps, the validation of the proposed ontology, along with its completeness test, and API. Furthermore, the usage of AI technologies, such as training machine learning models to classify text snippets to automatically instantiate the ontology, integrating with its API using the Python library OWLReady2 [14] is currently under development. Lastly, we are currently investigating the usage of the proposed ontology as the foundation for a Retrieval Augmented Generation (RAG) – which is a model capable of generating knowledge based on a retrieve-generate architecture, based on a knowledge

[11] https://protege.stanford.edu/

[12] https://github.com/VictorBenoiston/towards_legal_interoperability_SLR

[13] https://github.com/VictorBenoiston/policy_aspects_key_concepts_retriever

[14] https://pypi.org/project/owlready2/

source (Huang et al., 2023). In conclusion, we are actively looking for additional applications of the proposed ontology, better addressing the recovered gaps in the literature, and fostering the automation of processes regarding contractual issues in IDS.

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15

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