



Legal informatics from the aspect of interoperability: a review of systems, tools and ontologies

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ABSTRACT

In the reality of globalization, the legislation of every country needs to be followed in order to achieve a well-organized globalization process because the rule of Law is a cornerstone, a fundamental foundation of every democratic state and it should be observed and respected by all in the society. The economic and industrial globalization has increased international competition and given rise to the need for an increasingly integrated and evolving legal system but the fundamental debates over globalization of the 1990s more or less petered out, without leading to a clear consensus. So, society is still overwhelmed with an over-load of legal information while in the era of Digital Transformation, technologies such as Big data, artificial intelligence, machine learning, blockchain, 3D promise to have a profoundly disruptive effect on the industry, business models, governance models and on the way we interact with each other in society. However, there is not a legal information system capable of supporting the legislation of all countries in order to facilitate the above operation but there are many initiatives in order to develop legal ontologies. These legal ontologies in combination with the disruptive technologies can be help the problem of fragmented legal information across-border in order to create the Big Linked Open Legal Data.

CCS CONCEPTS

• **Applied computing** → **Computers in other domains** → Computing in government → *E-government*

KEYWORDS

Legal ontologies, Legal information systems, Legal Editing Tools, Legal text mining, Legal Interoperability

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1. INTRODUCTION

The globalization is the word used to describe the growing interdependence of the world's economies, cultures, and populations, brought about by cross-border trade in goods and services, technology, and flows of investment, people, and information. Countries have built economic partnerships to facilitate these movements over many centuries [1]. However, the legislation of every country needs to be followed in order to achieve a well-organized globalization process because the rule of Law is a cornerstone, a fundamental foundation of every democratic state and it should be observed and respected by all in the society.

The economic and industrial globalization has increased international competition and given rise to the need for an increasingly integrated and evolving legal system [2], in other words the globalization of law. By globalization of law, we might refer to the degree to which the whole world lives under a single set of legal rules. Such a single set of rules might be imposed by a single coercive actor, adopted by global consensus, or arrived at bay parallel development in all parts of the globe [3]. The fundamental debates over globalization of the 1990s more or less petered out, without leading to a clear consensus [4].

Thus, society is still overwhelmed with an over-load of legal information, only legal experts can follow the latest legislation and case law produced by parliaments and courts on a national and on multinational level. A large amount of information about laws that apply in the countries all over the world currently remains fragmented across multiple national databases,

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inaccessible systems, mainly consisting of documents (legislation acts, bills, case laws, resolutions, decisions), published in each country language. On the other hand, in the era of Digital Transformation, technologies such as Big data, artificial intelligence, machine learning, blockchain, 3D promise to have a profoundly disruptive effect on the industry, business models, governance models and on the way we interact with each other in society [5]. Furthermore, countries, all over the world, are emphasized the importance of interoperability for information sharing and cross-border interaction and already has changed the government's operations in many ways: establishing new agencies, restructuring the work units within ministries, passing a new law, and last but not least enabling interoperability across different government agencies [6].

However, there is not a legal information system capable of supporting the legislation of all countries in order to facilitate the above operation and also the economic and industrial globalization. The challenge for this to be achieved is the generation of a common metadata model for the legislation of every country. Nowadays, many initiatives are being taken to develop legal ontologies, legal information systems and legal editing tools in order to achieve the interoperability between the laws of different countries. However, these initiatives suffer from the fact that there is not a collective effort to create a multinational ontology that is complied with by all countries and all legal information systems or legal editing tools. Hence, the aim of this study of the literature is to identify the existing legal ontologies, the existing or under development legal information systems and the legal tools that are developing in order to achieve the interoperability of the legal framework cross-border.

The rest of this paper is organized as follows. The next section presents background information on the domain of legal informatics. Section 3 presents the followed methodology. Section 4 illustrate the results of the literature, the analysis of legal ontologies, the analysis of existing implementation of Legal Information Systems in the European Union and the tools that are exist for editing legal documents. In the final section the conclusions are summarized, and future research directions are proposed.

2. BACKGROUND

The term "informatics" can be tracked back to the 1960s and refers to the application of information technology to various fields, such as legal informatics, medical informatics, social informatics and organizational informatics [7]. In particular, Legal Informatics refer to the application of Information Technology within the context of legal environment [8] and is defined by Sactor and Francesconi [9] as the «theory and practice of computable law, i.e. the cooperation between humans and machines in legal problem-solving». Another approach is that legal informatics is the study of information technology in the field of law. The major areas that included in legal informatics domain [7] are:

- Storage and retrieval of sources of law
- Judicial administration

- Case management
- Automation of records of public/private interest
- Litigation support systems, legal expert systems
- Integrated legal information systems

During the last three decades and according to these major areas, several online consultation services and knowledge systems have been appeared in order to make services more open and promote access to legal resources. However, in the era of the World Wide Web – and particularly Semantic Web – and the immense data (and information) availability, there is a new awareness of citizens demands for greater transparency, and a belief that Open Data, particularly reuse of data, has the potential for a great impact on the economy and society [10]. The same awareness applies to legal documents in order to transform them in Open Legal Data. Furthermore, the transformation to Open Legal Data is not an easy process because the legal documents in most cases are available in non-machine-readable format and according to the five stars of Open Data [11], Legal Data should be:

- 1) Available on the web (whatever format), but with an open license useful for their reuse by third parties
- 2) Available as machine-readable structured data
- 3) As above plus non-proprietary format
- 4) All the above plus: use open standards from W3C (RDF and SPARQL) to identify things, so that people can point at data
- 5) All the above plus: link data to other datasets to provide extended context

Furthermore, the use of the followings design principles is mandatory in order to generate Linked Open Legal Data, as Linked Open Data:

- The use of URIs for identification
- To expose data for access via the HTTP protocol
- The use of the RDF data model to describe content of resources and to link them to other useful information

In a technical sense, the term open data refers to the "open" format with which digital data can be distributed on the web to make them more accessible, reusable and interconnected [12]. The interconnection of the linked open legal data is depending on the interoperability between the legal data from the different resources. The interoperability of the Linked Open Legal Data (LOLD) according to the four main levels of interoperability [13] depending from the Syntactic and Semantic interoperability. Specifically, well-defined metadata for all legal data resources are mandatory in order to interconnect different legal data resources, as well the use of standards in terms of exchange formats (e.g. XML, JSON, RDF/XML, RDF).

On the other hand, during the last two decades, a variety of initiatives has been implemented or is under-development in the domain of legal informatics using text mining, machine learning, natural language processing and neural networks.

Text mining, also known as text data mining, intelligent text analysis [14][15] or knowledge discovery from textual (structured) databases [16][17][18], has been defined as “the discovery by computer of new, previously unknown, information by automatically extracting information from different written resources” [19]. Generally, refers to the process of extracting interesting and non-trivial patterns or knowledge from unstructured text documents [16][17]. Legal text mining analyses legal texts in order to extract useful legal information such as an overview of text’s content [20]. Legal text documents are being unstructured stocked except in cases that online legal databases provide an easy access to citizens, businesses etc. Furthermore, as pointed out by Hearst (2003) [19] legal text documents are stored using natural language, so text mining can be suitably used for efficient analysis of such documents.

Machine Learning has been defined as the field of study that gives computer the ability to learn without being explicitly programmed [21]. Some of the techniques that can be used for the development of a Machine Learning Model are:

- Regression (Numeric Prediction)
- Classification (Detection among a known class)
- Clustering (Grouping of Data)
- Anomaly Detection

Furthermore, machine learning can be used to extract the parts of a legal document, to identify the correlations and generate a structure file of the legal document based on a legal ontology [22].

Natural Language Processing (NLP) has been defined by Jackson & Moulinier (2002) [23] as the function of software or hardware components in a computer system which analyze or synthesize spoken or written language. NLP can be used in order to:

- Assign pre-defined category labels to new documents [24]
- Understand the meaning of natural language [25]
- Labelling a word in a sentence or phrase to its appropriate part of speech type [26]

Generally, NLP techniques on structured and unstructured texts, with the view of extracting from large corpora (difficult to read) [27], can extract comprehensible, timely and direct insights for people’s opinions, emerging issues, trends, behavioral, events against policy topics [28].

Another interesting line of research links the neural network architectures to legal reasoning, in which neural networks are used as a parallel computational model for argumentation and allow to combine argumentation, quantitative reasoning and

statistical learning [29]. Finally, it needs to be investigated whether word patterns could be translated into latent variable concepts, which would support current interest in the use of factors in legal texts.

3. METHODOLOGY

This section presents the methodological approach of our study in order to complete a review of the current landscape of Legal Informatics following the snowball approach for redirecting to additional sources from the initial ones. We first conduct a literature review that enabled us to assemble the three categories of findings, legal ontologies, legal information systems and legal editing tools. In particular, the research began by searching for relevant publication in the Google Scholar using the following keywords: “legal documents interoperability”, “legal interoperability”, “interoperability of law”. Then it continued with a careful examination of three bibliographic databases, Scopus, IEEE Xplore and Web of Science using the same keywords.

Guided by the research papers, pinpointing specific categories of findings, identified in the previous step [30][31][32], the next step of our methodology consists the identification of initiatives relevant to legal informatics. Combined with desk research we analysed each initiative by its extension, the countries that are relevant and the legal ontology. The result of these steps (i.e literature, applications review, legal ontologies review, legal editing tools review) are reported in the following sections. In section 4 the results have been merged and analyzed.

The conclusions sections are derived from all the three steps of the methodology.

4. FINDINGS

4.1. Legal Ontologies

Legal Ontologies are being used to construct tools and prototypes to support the management, organization, search and retrieval of documents stored in legal databases [33]. In other words, legal ontologies have the ability to transform legal documents in a structure format in order to interconnect them and make added-value services which can even advise legal experts for a specific case using machine learning techniques, natural language processing and neural networks.

In particular, according to Valente (2005) [34] there are five roles of ontologies in general:

- a) organize and structure information;
- b) reasoning and problem solving;
- c) semantic indexing and search;
- d) semantics integration and interoperation; and
- e) understanding the domain.

One of the main advantages of using legal ontologies in order to represent legal documents is the ability of reusable them in other systems. Also, the legal ontologies can achieve

interoperability between the legal framework of two countries or more. However, the main challenge of a legal ontology is the ability to be described legal documents from all over the world.

Furthermore, Legal ontologies can contribute to the following areas [35]:

- Domain-theory development
- Knowledge acquisition
- System design
- System documentation
- Knowledge Exchange

According to the European Interoperability Framework the definition of Legal interoperability is about ensuring that organisations operating under different legal frameworks, policies and strategies are able to work together. This might require that legislation does not block the establishment of European public services within and between Member States and that there are clear agreements about how to deal with differences in legislation across borders, including the option of putting in place new legislation.

Nowadays, many researchers have focused in the development of a legal ontology in order to develop a legal information system or a better legal ontology than the previous ones (more descriptive) or to extend an existing legal ontology with new elements. This situation has driven to the development of many legal ontologies that are created for the same reason, to transform legal documents in a structure machine-readable format, and some of them are described below with their basic characteristics.

European Legislation identifier (ELI) is a framework to make legislation metadata available online in a standardized format, so that it can be accessed, exchanged and reused across border. ELI is described in RDF format in order to be stored in a triple-store and can be link the legal documents. The description of legislation in ELI follows the principles of FRBR. ELI has proposed a set of URI template but all the components of the URI Template are optional and not have a pre-defined order in order to select them based on national requirements.

Akoma Ntoso (AKN) is an international technical standard for representing executive, legislative, judiciary documents in a structured manner. The representation of AKN is an XML format and it's difficult to be described as an RDF in order to stored as triple stores because of the nested xml. AKN is emphasize in the workflow for an act inside the parliament as well as in the lifecycle. The lifecycle of an act includes the generation of the act, all amendments of the act and finally the withdraw of a law.

Legal Knowledge Interchange Format (LKIF) – Core Ontology is an ontology that has been created by an EU project named Estrella. The basic characteristic of LKIF is that enables the translation between legal knowledge bases written in different representation formats and formalisms. The LKIF is described as an RDF and can be easily store as triple stores creating linked data.

CEN Metalex is an ontology that standardizes the way in which sources of law and references to sources of law are to be

represented in XML. The basic characteristic of CEN Metalex is that impose a standardized view on legal documents for the purposes of information exchange and interoperability in the context of software engineering. Furthermore, CEN Metalex gives the opportunity for a schema extension, adding metadata, cross referencing, constructing compound documents and a basic naming convention based on a mechanism.

European Case Law Identifier (ECLI) is an ontology that has been developed to facilitate the correct and unequivocal citation of judgements from European and national courts. The ECLI is based on Dublin Core Metadata initiative for the metadata that are needed in order to understand and find a case law. Finally, the mandatory fields of ECLI are the “ECLI”, the country code, the code of the court, the year of the judgement and an ordinal number.

LegalRuleML is an extension of RuleML with formal features specific to legal norms, guidelines, policies and reasoning. The LegalRuleML has an XML representation in order to legal resources be available on the Web and can be described easily to RDF in order to stored as triple stores. The basic characteristic of this ontology is that linking rules and provisions based on IRI that allows many to many relationships among the rules and the textual provisions.

There are also many ontologies that are previous version of a new core ontology, such as LRI-Core or based on core ontologies such as EGO that reuses parts of LRI-Core model and not intended for legal domain, but for e-Government domain instead. Furthermore, there are some ontologies that constructed in a national level in order to cover a specific country, such as Taiwan Law Ontology, Finlex Legislation Metadata Schema, LexDania etc. Generally, most of the other ontologies are based on one or two or more core ontologies and domain ontologies that are prototypes.

4.2. Legal Information Systems

The continuously growing number of Legal Information Systems initiatives that are being adopted in the public sector by various states is a strong indicator of the current trend advocating the utilization of Legal Ontologies in Legal Information Systems in order to generate the Big Linked Open Legal Data (BLOLD) which give the opportunity to offer, a variety of new services, to citizens, business, public administrators, legal professionals which are needed in their everyday life. Especially, the adoption of Legal Ontologies from European Funded Projects is a key point for the future and under development legal information systems.

In the table below we present you some of the initiatives that are identified from our study.

Table 1: Legal Information Systems Initiatives

LEGAL INFORMATION SYSTEMS	SHORT DESCRIPTION
ManyLaws	The Manylaws is a European Project that extracting all the necessary information of the law using text mining and annotated it in a structure format
Lynx	The Lynx is a European Project that main object is to create an ecosystem of smart cloud services based on a legal knowledge graph.
EUCases	EUCases is a European Project that develops a legal information system in order to create a unique PanEuropean Platform for laws and case laws using text mining and natural language processing.
Caselex	Caselex is a unique and fast-growing legal information service aimed at serving antitrust/competition and M&A professionals around the world.
N-Lex	N-lex is a single-entry point to the national's legal databases
Openlaws.eu	Openlaws.eu is a European Project and a next-generation compliance and legal information system providing linking legal information.
legislation.gov.uk	Legislation.gov.uk is publishing all UK legislation in a structured format.
boe.es	Boe.es is the official gazette of Spain and represent the legal documents in a structured format.
EUAuthority	The EUAuthority is a European Project in order to investigates conflict and cooperation between domestic and supranational courts in the EU legal system using webscraping and text mining.
e-Justice	e-Justice portal is a one-stop-shop in order to inform citizens, businesses and legal professionals for the court decisions in the other member states or even in the same.
LexDatafication	LexDatafication is an information legal system that transforms legal data into a structure format and has the functionality of question & answering to the citizen
Normattiva.it	The Normattiva is an Italian government website that

	contains Italian law in a structured format.
Luxembourg Official Gazette	The Official Gazette of Luxembourg that offer legal documents in structured format.

In general, there are initiatives that are using some technologies or techniques in order to address the challenge of transforming the unstructured legal data of some states in a structured format. On the other hand, there are initiatives from the governments in order to transform legal documents into a structured, machine-readable format by hand. These initiatives are focusing only to the usage of the legal ontology in their legal documents than the initiatives that have the challenge to transform and interconnect different states legal framework. In the table (see Table 2) below you can find the extension of the initiatives, the countries that are related and the legal ontology which are using.

Table 2: The use of Legal Ontologies by Initiatives

INITIATIVE	EXTENSION	LEGAL ONTOLOGY	COUNTRIES	EU PROJECT	CAL
ManyLaws	Multinational	AKN, ELI	EU, EL, AT	Yes	CEF
Lynx	Multinational	LKG, ELI	EU, DE, AT, IT, ES	Yes	FP7
EUCases	Multinational	AKN	EU, AT, BG, FR, DE, IT, UK, DOJ	Yes	FP7
Caselex	Multinational	CaseLex metadata a set	EU Member States, EFTA	No	
N-Lex	Multinational	-	European Union	No	
Openlaws.eu	Multinational	-	AT, NL, UK	Yes	Civil Justice
legislation.gov.uk	National	AKN	UK	No	
boe.es	National	ELI	ES	No	
EUAuthority	Multinational	-	European Union	Yes	ERC
e-Justice	Multinational	ECLI	European Union	No	
LexDatafication	National	AKN	Italy	No	
Normattiva.it	National	NIR	Italy	No	

Luxembourg Official Gazette	National	AKN	Luxembourg	No	
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4.3. Legal Editing Tools

Legal Editing Tools (see Table 3) are used in order to help those who involved in drafting legislation or case laws. These tools have a variety of functionalities to facilitate the workflow of an act such as the dependencies/ conflicts with other national legal documents and international (e.g. EU Directives, EU Regulations).

In the table below we identified some of them and present them with a short description of the tool, the country that are used and the legal ontology that uses.

Table 3: Legal Editing Tools

TOOL	COUNTRY	LEGAL ONTOLOGY	DESCRIPTION
LEOS	European Union	ELI, AKN	Legislation Editing Open Software is designed for drafting legislation. LEOS includes comments, suggestions, version control, co-edition. LEOS is trying to be as stricted as is possible.
S.O.L.O.N II	France	-	SOLON II is based on macros and usage of over thirty templates in Open Office. This tool has the functionalities to create a document, updating a document, versioning and changes management and creating metadata.
LegisWrite /eNorm	Germany	xNorm	eNorm is a framework for applying structures. eNorm has the functionality of guidance in drafting a new document, internal cross-referencing, document quality and structure check.
At4am	European Commission	AKN	AT4AM is a web-based amendment authoring tool.
LexDania	Denmark	LexDania	LexDania editor allows editing XML files using a word processor interface.

LegIT	Commercial	-	LegIT is a case management tool and is especially designed for lawyers to organize their cases, billing and invoicing in a single place
Bitnomos	Commercial	AKN	Bitnomos is a commercial tool to support the digitalization of document workflow in Legislative Councils, Judicial courts, Official gazettes etc.
LegisPro	Commercial	AKN	LegisPro is a commercial tool to drafting legal documents

5. CONCLUSIONS / FURTHER WORK

This study has conducted a literature review towards the identification of used technologies, existing information system, editing tools and ontologies in the domain of legal informatics. Our findings indicate that there is a challenge for the future legal information systems due to the number of legal ontologies, meaning that legal data from different countries and continents are generated, in some cases, based on different ontologies. This situation creates interoperability problems because a mapping between legal ontologies is needed and there is not a clear answer if all elements from one legal ontology can be transferred to another. So, a mapping and a comparison between legal ontologies are needed in a future research work in order to address the above challenge. Furthermore, in the era of Digital Transformation and globalization a consensus is needed about the prototype that legal data will follow in order to create Big Linked Open Legal Data (BLOLD).

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