Towards a Foundation for Intelligent Contracts

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Abstract: This article investigates the incorporation of Artificial Intelligence (AI) within LegalTech. We define an ontology to form the basis for Trustworthy AI processing of contract automation. The value of our research is that it applies an ontology, as existing tool, in contract automation. Two perspectives are emphasized: communications analysis and risk analysis. They are explored under a new prism. Our context is Intelligent Contracts (iContracts), which aim at reducing the time-consuming and often complex contractual process by minimizing human involvement. Contract communications and risk analysis processes are often neglected in automation. Therefore, our research investigates to what extent is possible to design an ontology for contract automation based upon the combination of both. Our methodology is twofolded. First, we concentrate on applying key word search on an online database to demonstrate the lack of available solutions. Second, we develop an ontology based upon a case study of a freelancer agreement. Of course, we use existing literature to further engineer the ontology. Our finding shows that 9.4 percent of LegalTech solutions deal with contract automation. From them, 0.7 percent focus on communications and risk automation for contracting. The conceptual expressiveness of the ontology is validated with research to the use case. A follow-up discussion suggests that the ontology should be further engineered from a third perspective, *trustworthiness*, and should be re-validated experimentally. Our conclusion underlines the need for further innovation in contract automation, especially in relation to communications and risk data.

1 INTRODUCTION

The promise of a gift is different from the gift of a promise. Both are attractive. However, the following questions arise. Which one is better or which one is always the best? Can we utilize an ontology to guide us in difficult decisions? And to what extent can Artificial Intelligence's (AI) involvement aid us?

While global media outlets often advance claims discussing the replacement of humans by robots in the labour market, social confusion often ensues (Larson, 2021). The same holds for the legal world. Universities, law firms, and startups from around the world are often showcasing their innovative activities in the field of AI and LegalTech. However, such marketing promotions increase the difficulty in deciphering what is the actual social progress in innovation. Therefore, the aim of our paper is twofold: (1) to clarify the state-of-the-art innovations in contract automation (i.e. a particular field of AI and Law), and (2) to lay the foundations of Intelligent Contracts (iContracts).

1.1 Three Innovations

Recently, the field of contract automation has experienced three major innovation. The first is the digitalisation of contract management (hereinafter *digital contracts*), where certain contractual processes are

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digitised, such as signing, drafting, storing, reviewing, sharing, and analyzing contracts (Timmer, 2019). The second innovation regards the rise of *smart* contracts demonstrating that parties can reach and execute agreements via programming (Kolvart et al., 2016). Today we are facing the dawn of the third innovation, namely *iContracts*. iContracts introduce a hybrid approach between human and computer interventions aiming at achieving full automation with self-executing contracts (Mason, 2017). iContracts introduce the state-of-the-art innovations in the space of contact automation due to their compliance with Hybrid AI principles (Huizing et al., 2020).

1.2 Four Challenges

There are multiple challenges with digital, smart, and intelligent contracts. They span from usability and adoption challenges, to the automation of contract execution monitoring and dispute resolution. Yet, one of the major challenges observed is that the communication process preceding the drafting of contracts is often neglected. During the communication, contracting parties exchange useful information that affect the design of contracts. Typically, a legal expert leverages the information and analyses the risks that may derive, for example, from relevant legal rules (Stark, 2013) in order to draft a contract.

The above-described situation can be exemplified as follows. A client who has a design problem and an according budget, contacts a freelance designer with the intention to hire him/her/it. To initiate the project, the client and the designer (henceforth the contractors) need to have either a written or verbal agreement. If the agreement is written, both parties are legally protected to a higher extent, because as the popular proverb says: *verba volant, scripta manent*.

In the context of a freelancer agreement, the drafting of the contract is usually entrusted to legal experts; mostly due to the lack of legal knowledge of contractors. However, not all freelancer agreements take a written form. Additionally, practice shows that there are multiple challenges involved in the process. In the subsequent part, we discuss *four of them*.

The first challenge concerns *the actual implementation of the freelancer agreement*. Contractors involved in freelance projects usually tend to agree verbally. According to the freelancers union, 72 percent of freelancers do not use written contracts [1].

Second, we examine the *issue of pricing*. A client holds certain budget and needs a landing page for a website. The client can contact designers with different pricing and quality points. The quality of a deliverable may be lower than the client's expectation, leading the client to not compensate the designer. If there is no contract, the designer cannot legally claim the amount owed.

Third, a challenge during the communication phase of contracting is that *discussions can be abstract and require specific legal knowledge*. The presence of a legal expert in the information collection process narrows down the scope of the discussion. Moreover, an experienced legal expert connects the information exchanged with the relevant risks, before designing the contract (Eggleston et al., 2000).

Fourth, the *technological* challenge is that despite the availability of many contract automation technology solutions, the legal *communication* and *risk* analysis processes are not often automated. As a result, today's legal experts spend significant time collecting information from the communication exchange between contracting parties and analyzing risks before drafting a secure contract.

iContracts can greatly benefit each described challenge, because they introduce practical, data-driven solutions. Gradually, the solutions can be applied in more complex contexts, including for example enterprise or government contractors. So far the main alternative for freelancers or organisations is mostly reliant on physical contract interventions that are hardly scalable. The focus of our research is sufficient to demonstrate how iContracts benefits small scale challenges, for future application in more complex environments.

1.3 Two Possible Solutions

Automating the legal communication and risk analysis processes can benefit the contracting parties. The ultimate beneficiary of such automation would be the non-legal experts, since they can leverage the automation of the contracting process. However, one should not rush to avoid the inclusion of a legal expert or attempt to avoid one altogether. At this moment we are cautious to note that automation cannot be immediately successful for all types of contracts. Therefore, our research focuses on a straightforward contracting case study.

The case study concerns a contract regarding the provision of freelance services. The scope of this paper will be limited to this case study, as there is often little contract communication and risk analysis required before drafting such a contract.

If the automation proves to be successful, gradually this automation can be applied to more com-

[1] https://blog.freelancersunion.org/2015/12/21/why-do-only-28-freelancers-use-contract/

plex types of contracts. Due to lack of literature for the specific type of automation, there are no available data sources structured accordingly. As a consequence, collecting and building data-sets will be hard.

Hence, as matters now stand, it becomes imperative for AI and LegalTech researchers to structure the available data for automating a contract in the present context. The process of structuring data may involve many diverse challenges such as selecting the right contract templates, gathering multiple communication data and analyzing multiple risks in order to make secure contracts. Yet, the most prominent challenge is: *how the communication and risk analysis processes can be handled in a harmonised, scientific manner?*

1.4 Three Research Approaches

To address the issues involved, we are asking the question: can Machine Learning (ML) help us? There are three available options. First, a ML approach, whereas an unsupervised ML algorithm can be applied to any available contract data. Yet, such data are hard, if not impossible, to find or obtain. Second, a relational-data model can be developed that demonstrates how various data sources connect with each other. Yet, such a model may be limited for the application of AI. Third, ontology engineering is an option. Ontologies demonstrate how it is possible to handle interconnected data sources with a great variety of data types. They are able to support the structuring of data in a scientific manner (Duan et al., 2017). The benefits of developing an ontology relate to interoperability, standardisation, conceptualisation, inferential reasoning and information retrieval.

Hence, we choose an ontology to serve as the backbone of an explainable "intelligent" platform where various modern technologies can be incorporated and tested (Sarker et al., 2020). The core module of this platform will utilise modern models and techniques in the field of AI.

The value of the ontology stems from its potential to support the implementation of communication and risk management in contract automation. It is extendable, can support additional solutions and clarify limitations. In essence, an ontology can be the method that helps the systematic study of contract automation, towards achieving the goal of iContracts. Hence, following the discussion, it logically follows to begin by creating an ontology that increases the transparency of the communication and risk processes in contract automation.

The above-mentioned information lead us to the following Research Question (RQ): *To what extent is it possible to define an ontology to sufficiently automate contracts based on communications and risk data?*

To answer the RQ, we structured the paper as follows. In Section 2, the literature is described. Section 3 presents the method of research. Then, Section 4 states the results of our research and Section 5 discusses those results. Finally, Section 6 answers the RQ and provides our conclusion.

2 LITERATURE

The literature Section is structured as follows. Subsection 2.1 introduces contract law. Subsection 2.2 presents sources on contract automation solutions. Subsection 2.3 introduces contract communication literature. Subsection 2.4 discusses the literature on legal risk. Then, Subsection 2.5 introduces the state-of-the-art literature on smart contracts. Subsection 2.6 discusses iContracts. Subsection 2.7 states forth the literature of ontology engineering. Subsection 2.8 presents the relevant ontology literature on contract automation.

2.1 Contract Law

In most jurisdictions around the world, contracts are defined as follows.

- Definition 1: A **contract** is a legally binding agreement, verbal or written. (Smits, 2017)

For an agreement to be binding, certain requirements must be met. Those requirements are usually laid out in the contract law of the relevant state, which typically also ensures that conflicts can be resolved through the court system In general, contracts are governed by private law and in each jurisdiction there are certain rules for contracting. Generally, those rules may be substantively divergent. In this research, this divergence is limited to the lowest extent possible as one of the simplest forms of contracts is used in the case study, in other words, the freelance agreement.

2.2 Contract Automation Solutions

The two largest online databases on available contract automation solutions are (1) Stanford University's *Legaltechlist* [2] and (2) Legalpioneer.org [3]. *Legaltechlist*, is a strictly curated database while the *Legalpioneer* list is a more extensive database. At the time

[2]https://techindex.law.stanford.edu
[3]https://www.legalpioneer.org/

this research was conducted (September 2022), Stanford's website has a total of 1,962 results and Legalpioneer's website has 9,608 business cases archived. In these databases, the amount of available contract automation solutions that relate with this research will be identified. We decided to focus on identifying companies in *Legalpioneer* due to the larger amount of available data. These data is expected to support the importance of our research scope.

2.3 Contract Communication

Most of the available literature on contract communication is focused on *contract negotiations*. The word "communication" concerns to a larger extent how contracting parties should talk with each other, in order to gain a negotiation advantage, reach an agreement, and avoid the escalation of conflicts. Here we remark that in our research, the word "communication" refers to the substantive information that is directly relevant for the design of a contract.

2.4 Legal Risk

The first framework for the management of contractual risks emerged in 1950 with the introduction of *Preventive Law* by the lawyer and attorney Louis M. Brown. (Brown and Rubin, 1950) Brown believed that preventive law concerns the cost difference between entering into and avoiding legal costs. He thought that legal problems arise because of legal risks. At the end of the century, his student, Eduard A. Dauer, started the development of a systematic analysis for the management of legal risks (Dauer, 1987). In 2002, the academic Thomas D. Barton took an interest in continuing this line of research by advancing Dauer's analysis further with his own method (Barton, 2002)

Around the same time, in 1998, the lawyer and academic Helena Haapio introduced the concept of *Proactive Law* (Haapio and Varjonen, 1998). Proactive law is a future-oriented approach to law and legal agreements, placing an emphasis on legal knowledge to be applied before things go awry [4]. The difference between preventive and proactive law is that the latter, except from the preventive dimension, adds the promotive dimension in terms of good and desirable behavior (Berger-Walliser, 2012). Haapio is mostly concerned with the application of proactive law in contracts.

In 2010, she created a synergy between proactive law and the United States school of law as a competitive advantage with the academic George J. Siedel (Haapio and Siedel, 2010). As a consequence of this synergy, in 2013 they published the book *A Short Guide to Contract Risk* where they analyze contractual legal risks (Haapio and J, 2013). At around the same time in 2010, Haapio introduced the theory of legal design, which advances the theory of Preventive/Proactive Law (PPL) by translating complex legal language into clear language expressions and visualizations, so that contracts can be understood by everyone before legal problems arise (Berger-Walliser et al., 2017).

In 2004, the academic Jon Iversen introduced *Legal Risk Management* (Iversen, 2004). Then, in 2007, the academic Tobias Mahler discovered the difficulty in defining legal risk and how diverse it is (Mahler, 2007). Following the introduction of a compliance risk management by ISO (International Standardization Organization) in 2014 (Bleker and Hortensius, 2014), Mahler along with the academic Samson Essayas, set out to systematically analyze and model compliance risk in 2015 (Esayas and Mahler, 2015). Recently in 2020, ISO introduced the first Legal Risk Management (LRM) standard focused exclusively on legal risk for organizations and defines *legal risk* as follows(ISO, 2020).

- Definition 2: **Legal risk** is risk (effect of uncertainty on objectives) related to legal, regulatory and contractual matters, and from non—contractual rights and obligations.

2.5 *Smart* Contracts

Today the research of PPL focuses on smart contracts (Corrales et al., 2019b).

- Definition 3: A **smart contract** is a computerized transaction protocol that executes the terms of a contract.(Szabo et al., 1994)

Essentially smart contracts refer to the programming functionalities of legal contracts (Kolvart et al., 2016). Smart contracts were introduced to the public initially via blockchain technologies. Bitcoin introduced the first peer-to-peer electronic payment system, which manages transactions without any need for intermediaries [5]. Then, Ethereum, expanded upon this technology by managing to codify the necessities for the satisfaction of contracts by adding certain milestones, specifying which work could be used as insurance for payments, creating smart contracts [6]. Even though smart contracts have been popularised via blockchain-based decentralized applications, theoretically they

[4] http://www.juridicum.su.se/proactivelaw/

[5] www.bitcoin.org

[6] www.ethereum.org

can also be applied on centralized applications [7].

The novelty from the use of smart contracts in LegalTech stems from the adoption of computer code instead of human language for managing contracts (Kozlova and Aleksandrina, 2020). It is from this perspective that the school of legal visualisation under PPL is conducting research on smart contracts, so that the smart contract rules are more understandable and accessible for contractors (Corrales et al., 2019a) (Barton et al., 2019). Haapio often emphasises the importance of design for contracts, but that it is particular so for smart contracts (Hazard and Haapio, 2017).

2.6 *Intelligent* Contracts

In essence, smart contracts work when one is able to manage and prove milestones. On a macro level, applying this technology in a complex legal situation unfolding in, for example, an energy project would require higher sophistication. This higher sophistication is examined under the aegis of *intelligent contracts* or *iContracts* (McNamara and Sepasgozar, 2021). So far iContracts are defined as follows.

- Definition 4: An **intelligent contract** or **iContract** is a contract that is fully executable without human intervention [8].

This field introduces a hybrid contract automation approach and considers the need for contract automation that correspond to the complexities of reality, aiming for the transition into full self-executing automation, with minimal human intervention or without it, if possible (Mason, 2017). Motivated by the developments in Industry 4.0, this field is mostly evident in construction (McNamara and Sepasgozar, 2018), where a high level of complexity drives the need for such innovation (McNamara, 2020); the same can be said for smart factories (Aimin and Yunfeng, 2019). Despite the large academic call for the need of iContracts and the developing frameworks for its adoption (Pillai and Adavi, 2013), many acceptance challenges are evident in practice (McNamara and Sepasgozar, 2020). The key value of iContracts is that they can leverage information from smart Internet of Things (IoT) sensors for automated monitoring of contracts (McNamara and Sepasgozar, 2020). It should be noted here that iContracts can be implemented in both centralised and decentralised systems (Zheng et al., 2020).

The iContract developments prove that the monitoring and execution of contracts is more related with project management. However, the level of project management with respect to technological readiness is diverse. For example, in a freelance agreement, where there is a lack of IoT sensors, it would be harder to monitor a contract.

2.7 Ontology Engineering

To advance the field of contract automation, we need annotated data (deterministic data for the application of expert system algorithms, and probabilistic data for the application of Machine Learning (ML) algorithms) (Macmullen, 2005) which must be encoded into a machine-friendly structure. This is vital for AI applications, which include not exclusively (1) game playing, (2) speech recognition, (3) understanding natural language, (4) computer vision, (5) expert systems, and (6) heuristics classification (McCarthy, 2004). We believe that a new structure heavily relies on the development of an ontology. An ontology is used in many different ways in literature but its original meaning comes from Philosophy. It concerns the study of being or being existent (Gruber, 1993a) (Guarino et al., 2009) and includes things that exist in the real world. In our work, we define ontology as follows.

- Definition 5: **Ontology** is a formal, explicit specification of a shared conceptualization that is characterized by high semantic expressiveness required for increased complexity (Feilmayr and Wöß, 2016).

We should note here that ontologies are closely interconnected with Knowledge Graphs (KGs). Ontologies represent the context (t-box as in tool box) while KGs are the tool used to utilize them (a-box as in algorithmic box).

- Definition 6: A **Knowledge Graph** is defined as a 4-tuple G = (N, E, L, f) being a directed labeled graph, where N is a set of nodes, $E \subseteq N \times N$ is a set of edges, L is a set of labels, and f: $E \rightarrow L$ is an assignment function from edges to labels.

The assignment of a label B to an edge E=(A,C) can be viewed as a triple (A,B,C).The triple A, B, C is referred to as the subject, the predicate, and the object of the triple, respectively. KGs have been instrumental in the context of knowledge representation learning as they can store output data in a standardised format, simultaneously consuming the data to obtain domain knowledge (Vinay K. Chaudhri,). Our interest here lies in KGs' property to capture ontologies (Gruber, 1993b). An example of a triple in our case study is that a (A) legal expert (B) designs a (C) contract.

[7]https://contractbook.com/blog/smart-contracts-without-blockchain

[8]https://bravenewcoin.com/insights/pamela-morgan-at-bitcoin-south-innovating-legal-systems-through-blockchain-technology

In the end, an ontology serves to create a formal representation of the entities in the graph. The difference between a KG and an ontology is that the former includes an ontology as well as data that validate it. Both ontologies and KGs are based on the Resource Description Framework (RDF) (Group, b) triples. They have a similar representation style and tend to resemble each other in visualizations, although ontologies are usually based on a taxonomy (Education,). It is interesting to see that they can contain multiple taxonomies, thus having their own definitions. The Web Ontology Language (OWL) (Group, a), the Semantic Web Rule Language (SWRL) (Ian Horrocks,) along with RDF belong to a family of representation languages standardised by the World Wide Web Consortium (W3C) (w3c,) with the goal to capture knowledge on the internet.

Creating an ontology can be done in many ways by supplementing manual knowledge engineering techniques with significant automation and crowdsourcing. More precisely, ontologies can be learned from unstructured or semi-structured data sources, assembled from existing ontologies, usually aided by various semi/fully-automated data validation and integration mechanisms, or created from scratch by domain experts (Paulheim, 2017).

2.8 Ontologies in Contract Automation

So far ontologies have been applied multiple times in a legal context, but not for the specific context of contract automation via *communication* and *risk* data. We provide five examples: for the structuring of legal norms and court decisions (Filtz, 2017), for posing legal questions related to legislative sources and answering them (Sovrano et al., 2020), for compliance purposes in complex multi-lingual, multi-jurisdictional environments (Schneider et al., 2022) (Montiel-Ponsoda et al., 2018), for online case analysis (Yu et al., 2021), and similarly, for case recommendations (Dhani et al., 2021). In relation to contract automation, ontologies have been used for conceptualizing contracting terms and promoting interoperability regarding concepts (García and Gil, 2008) as well as on infological- and datalogical-level data exchanges for blockchain-based smart contracts (Kruijff and Weigand, 2017). Moreover, they have been exploited more generally for blockchain-based smart contracts (Zhou et al., 2020) and other research concerning contracts (Kaltenboeck et al., 2022) or contract risk management (Wu, 2020), albeit at a higher level of abstraction. The closest research to date on our subject is that of Legislate, where they use an ontology for *drafting* and *negotiating* contracts as well as representing *rights* and *obligations*, which happens behind closed doors as their KGs [9] are protected by a patent on semantic document generation [10]. In addition to all the applications, our research is applying ontologies from the perspective of communication and risk data automation which makes it unique in the available body of literature. The potential of applying ontologies in the legal domain may even reach the level of developing industry-wide interoperability standards, in the same way that it occurred in the financial industry via the Financial Industry Business Ontology (FIBO) [11].

3 RESEARCH METHOD

The methodology initially concerns the analysis of Legalpioneer data which is based on Key Word Search (3.1). Then, for ontology engineering, the methodology follows two stages. Determining the Case Study (3.2), and defining of the ontology (3.3).

3.1 Key Word Search

To gather data in Legalpioneer we had to conduct key word search, with the expectation of identifying the available contract automation solutions today. After typing in the key words "contract automation", around 905 results appeared. We manually analyzed every single result presented after a search, including their respective websites, and conducted analaysis about their relevance and connection to our research. We identified two numbers: (1) the percentage of the total contract automation solutions in all available LegalTech solutions, and (2) the percentage of contract automation solutions based on communication and risk management in all available contract automation solutions.

3.2 Case Study

The scope of this case study concentrates on a freelancer agreement. To get this agreement, we downloaded an NDA agreement from the open-source legal documentation database of Capital Waters [12]and we adjusted it to fit the needs of our case study.

[9]https://www.legislate.tech/post/knowledge-graphs-know-more-about-your-contracts

[10]United States Patent 11087219

[11]https://edmcouncil.org/page/financialindustrybusinessontology

[12]https://www.capitalwaters.nl

3.3 Ontology Engineering

To design an ontology, requirements need to be gathered. The requirements collected for the design of the ontology are based on the case study and a literature review. Taking into consideration the requirements, we arrived at the Onassis Ontology, which is visible in Figure 1 and accessible via Github [13].

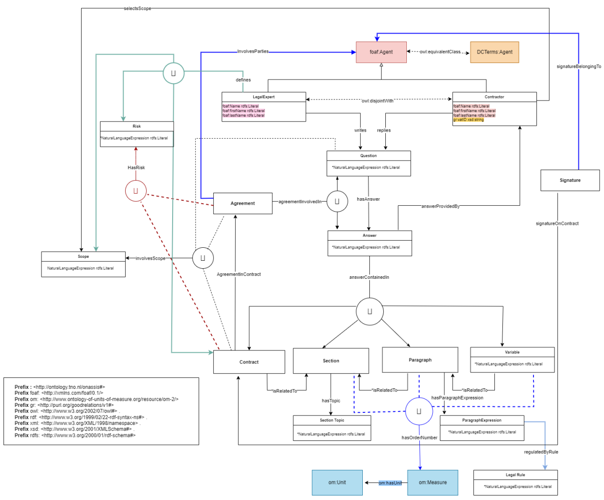

Figure 1: A visualization of Onassis Ontology.

The ontology that we designed retraces the interactive process of *asking questions* and *giving answers* between a legal expert and a contractor. The process that we aim to frame for automated methods (and consequently bind it to a formal contract) can be presented through the following ontological conceptualization.

The starting points of the above-mentioned interactive process are the legal expert and the contractor. The legal expert writes a question for the contractor who has previously selected a specific scope for the contract. By replying to the question, the contractor provides an answer. On a "physical level", the answer occupies a position in (1) a variable of a paragraph, (2) a paragraph of a section, (3) a section of a contract, and (4) a contract. The variable, paragraph, and section follows a numerical order within the constituent parts of the digital document (i.e., the contract). The paragraphs of a section (i.e., the section itself) are grouped under standardised topics and are regulated by legal rules.

The contract contains various numbers of agreements. An agreement here is conceived as a consensus involving at least two different parties and regarding an answer and a question. Every time that a question is asked by a legal expert and an answer is provided by a contractor, an agreement takes place. The contract and agreement are always associated with a risk that is defined by the legal expert. The risk, as well as all the additional constituent parts of the contract, can be reviewed by the contractor before signing the contract. He/she/it is ultimately in charge to decide whether or not to enter in a legally binding agreement with the other involved party or parties.

To design the vocabulary terms of the ontology described above, we used the Resource Description Framework Schema (RDF/S) and Web Ontology Language (OWL). Onassis reuses the following external Vocabularies: (1) the Friend of a Friend Ontology (FOAF), (2) the Ontology of Units of Measure (OUM), and (3) the Good Relations Vocabulary (GR).

The logical consistency of the ontology has been tested by launching the reasoner Hermit 1.4.3.456 on sample data in Protégé editor. The use case employed is presented in the results.

4 RESULTS

The results of our research are twofold. The first result is (4.1) the percentage of available contract automation solutions relating to the scope of this research based on the Legalpioneer data. The second result is (4.2) the KG that works as a validation mechanism for the ontology.

4.1 Contract Automation Solutions

After the key word search in Legalpioneer the following two results were evident, for (1) contract automation and (2) contract automation based on communication and risk data. First, given the 905 results for contract automation out of the total of 9,608 LegalTech solutions, the percentage of contract automation solutions is 9.4 percent. Second, there are a total of 10 solutions related to communication and risk management contract automation, which is 0.7 percent of the total of 905 contract automation solutions. The second finding is based on the following three results. (A) Six companies are developing technologies related to contract communication automation (legislate.tech, lawcus.com, casestatus.com, app4legal.com, lawren.io, and joseflegal.com). (B) Two companies are developing contract risk automation technology (sirionlabs.com and icertis.com). (C) Two companies are merging communications and risk automation but for contracting

[13] Onassis is accessible at https://github.com/onassisontology/onassisontology and is protected by the open-source GNU General Public License https://www.gnu.org/licenses/gpl-3.0.html

(cognitiveview.com and smarsh.com). The results indicate that despite the abundance of contract automation solutions, there is a significant omission for solutions which are focused on communications and risk data analysis.

4.2 Knowledge Graph

To validate the coherency of the ontology with the domain knowledge, we ran competency questions on the instance data that we structured via the vocabulary terms of the Onassis ontology. The process demonstrates the level of expressiveness of the vocabulary. At present, Onassis can support the following use case scenario, the visualization of which is presented in Figure 2 and can be accessed via the GitHub page.[14]

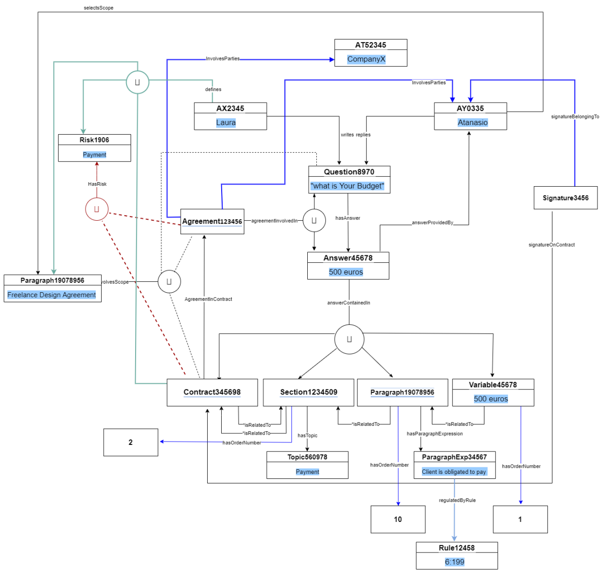

Figure 2: Visualization of the use case scenario modeled with Onassis's ontological expressiveness. In the figure, individuals are represented as rectangles. Their associated datatype values are highlighted in blue. Relationships are represented as arrows.

In the use case scenario, Laura, who is seen as a legal expert, defines both the scope of the agreement to be a freelance design agreement and the risk (which in this case is a payment risk). Successively, she writes the question "what is the budget?" and waits for an answer. Atanasio, as a contractor, selects the scope of the agreement to be a freelance design agreement. Subsequently, he indicates his budget (500 euros) as an answer. The answer provided by Atanasio updates the variable uniquely identified by the number 124590456, related to paragraph 19078956, of section 1234509, of contract 345698. The variable, paragraph and section have an order number in their related parts. The question asked by Laura and the answer provided by Atanasio are involved in the agreement number 123456, which can have a maximum of one question and one answer. In fact, for every question asked and answer given, a uniquely identified agreement is created. Multiple agreements can be part of a same uniquely identified contract. Once Atanasio has reviewed the legal document he can sign it by adding his signature on the contract. This action will legally bind the parties involved in the various agreements connected to the same scope within a sole contract. The data shows that our ontology structure is robust for the requirements of a freelance agreement.

[14] https://github.com/onassisontology/onassisontology

5 DISCUSSION

The discussion concentrates on analyzing (5.1) the database findings, (5.2) the ontology engineering, (5.3) the AI applications, (5.4) iContracts, and (5.5) the added benefits.

5.1 Database findings

The finding that 9.4 percent of the total LegalTech solutions focus on contract automation proves how substantial innovation in contracting exists. Yet, the finding that only 0.7 percent of those contract automation solutions focus on the automation of communication and risk data, proves how far we still are from adopting mature intelligent contracting solutions.

A general comment on the inspected data is that most of the technologies investigated address the legal experts as users and not the contractors as users. Regarding the contract communication automation solutions, none of the them generates the contracts as an output automatically. As for the contract risk automation solutions, even though legal risk is part of every contracting process, such solutions are not widely available. Most risk-related solutions identified relate to compliance automation.

5.2 Ontology Engineering

Looking back at the pricing example of our research introduction, the ontology can help contractors specify an optimum pricing in balance with a normative specification of the qualitative expectation for both parties. As presented, this can be done by finding a middle ground between two sets of answers that the contractors have provided. In this way, the risk between two parties for a dispute is minimized, as well as the potential consequential costs for both of them.

The ontology is novel on a legal level as it represents how a mature legal expert handles contracts. This has not done before according to literature on ontological representation level. In that respect, the ontology is novel as it provides a practical tool for the legal world rather than providing just another theory. With the rise of LegalTech, the production of tools in academic research are becoming more common. This research further demonstrates the need for such practical tools. Moreover, the ontology adds value for both smart contracts and iContracts, as it demonstrates the extent to which certain processes can be programmed and those which cannot.

The novelty of the ontology is that it has conceptualized a new domain, which benefits the world of ontology at a vocabulary level. In extension, this novelty is relevant for semantics, as it demonstrates how the semantics of contract automation work at this level of conceptualisation. The end-value of the ontology should be examined by an experimental view in future research, in particular from two perspectives. The first perspective needs to ensure that the activities involving the legal expert are designed in a trustworthy manner. The second perspective needs to ensure that the activities involving the contractors are designed in a trustworthy manner. Only then it is possible to validate the design of the ontology and justify its application in real-life experimental use cases.

By making the ontology publicly available we achieve two levels of innovation. First, we can stay connected with state-of-the-art developments as the feedback based on iterations increases as opposed to if this ontology would stay behind closed doors. It also becomes more accessible to the public and its development becomes more academically trustworthy. Second, the open source model goes against the monopolistic power that some corporations follow in innovation, which slows general innovation and social progress.

The present research is relevant for three reasons. First, the Onassis ontology can provide a framework for managing risks in contract automation in a trustworthy manner as well as preventing contract disputes. Second, it can pave the way for demonstrating how it is possible to standardise contract drafting languages in order for contracting to become more interoperable. Third, it can maximise the value contractors extract from contract automation via the application of AI in a more trustworthy manner than the available technologies, due to making explicit an analysis process which is usually implicit.

After the ontology has been validated, its potential value can influence contract automation significantly. Legal experts may no longer be involved physically in contracting processes between two or more parties; their interaction may only occur using a computer. The contractors will be able to: (1) obtain a contract more rapidly, and (2) trust its content, without having to enter into extensive discussions.

5.3 AI Applications

The value of the ontology for AI is that it reduces complexity and helps clarify how advanced ML algorithms can be applied. Moreover it can help make the algorithmic results explainable. Still, in some cases involving data, such as risk data, bias is present and should be addressed.

At this point, three relevant AI applications that can be implemented with the ontology to achieve a higher degree of automation are presented. (A) Text extraction can be used to automatically extract the answers of the contracts from the questions. (B) Data extraction can also be used to automatically extract risks for a specific contract. (C) Text generation can be used to draft a contract based on extracted risk data. Based upon this, we can see how ML algorithms can also applied for classification or prediction.

As a result of AI applications, certain analytic benefits may arise as well. In general, an ontology can be used to analyse qualitative theory quantitatively. Moreover, following the same pricing example, we can quantify what is more precise or faster: the traditional contracting process, the programmed smart contract process, or the hybrid intelligent contract process? Also, nuanced data analytics can provide insights that can be used in order to quickly prove which party is at fault in case of a payment dispute regarding quality.

In addition, there are also benefits at the level of logical reasoning. We can define a set of rules for recurring entities, so as to examine which classes are the best candidates for codependency influencing such relations, and apply advanced reasoning to uncover hidden data or further relations. The value of this inferential reasoning is that it can support automated reasoning for automated dispute resolution.

5.4 Intelligent Contracts

In the same way that smart contracts began with cryptocurrencies and are now applied in more use cases, the iContract literature should gradually expand into more directions as well. In the present research, we make a first attempt in demonstrating how iContracts apply in a freelance project. Moreover, further scientific examination of the iContracts concept should occur to help specify their general value for LegalTech, as well as for AI. A valuable addition that iContracts bring in contract automation is that they point in the direction of monitoring during the contract execution stage. It is in fact vital that for a higher degree of automation to be achieved, project data should be connected with iContracts. By expanding the scope of contract automation during the execution phase, the management of risks also improves. By connecting iContracts with realistic project execution, this higher effectiveness in contract execution can also be achieved. This is where PPL, and in particular legal visualisation, can help due to the lack of sufficient frameworks. Adding on that, the ontology can help by standardising data classes while a more harmonised approach can be taken for the classification and collection of such data. To that end, more research in the field of how iContracts can benefit from IoT devices, as well as how they connect more generally with project management, would be useful.

5.5 Added Benefits

One of the main benefits for iContracts automation for complex projects relates with insurance premiums. In general, by having better risk predictions, insurances can be provided with more accuracy and the premiums calculated more realistically. This has a direct effect on the operational expenses of organisations. It also has an effect on the policy choices they make, as by being able to better measure contract risk, improved policy-making is possible. Moreover, in such projects where there is often complex contractor and sub-contractor relationships, the main contract ends up bearing the major risks; by improving iContracts from the perspective of risk management, there are added benefits for the main contractors.

Last but not least, risk frameworks are not standardised in legal practice as they are, for example, in the energy or finance sectors. That is potentially because the underlying legal practice is already sufficiently complex. iContracts help as they can create the space for responsible risk management based on validated frameworks, and by reducing workload. Currently the proactiveness of contracts is not measured, so iContracts can also help with quantifying risk.

6 CONCLUSION

The below Subsections provide the answer to the RQ (6.1), further research suggestions (6.2) and the research novelty (6.3).

6.1 Answer to the RQ

The paper progresses the state-of-the-art in ontologies for the legal domain by providing an approach for contract automation based on communications and risk data. The RQ of this research is *To what extent is it possible to define an ontology to sufficiently automate contracts based on communications and risk data?*.

The answer to the RQ is that defining an ontology for this purpose is possible for sufficient automation. However, it remains essential to test extensively its validity, and to conduct further research to ensure an adequate level of trustworthiness for any action the legal expert and contractors will be involved in.

Moreover, the finding that only 0.7 percent of the total contract automation solutions in the Legalpioneer database concentrate on automating contract communications and risk data demonstrate a significant omission in existing solutions. This omission justifies our scientific attention to the subject. The aims for this research was to bridge the gap between smart contracts and iContracts and to clarify our stance. All in all, we may conclude that automating a contract based on communications and risk processes, which have long been neglected, can prove to be the missing link in realising both self-executing contracts and iContracts.

6.2 Further Research

The key question at this point is how to best move forward from here. An essential step in conducting further research is to understand the correlation of the ontology classes. By selecting certain correlated classes, we may conduct specific quantitative or qualitative experiments to further our research. Based on the aforementioned discussion, the communications and risk processes need to be examined more deeply. Therefore, our follow-up research will focus (1) on the legal expert-based inputs and outputs , (2) on the contractor-based inputs and outputs (responsible contract communication management), and (3) on the experimental validity of the KG. Through this examination and validation, our ontology may be improved upon and expanded.

6.3 Research Novelty

An intriguing question that arose while conducting this research was: to what extent is our research *innovative*? And further, to what extent is it likely for iContracts to become a separate scientific discipline for study? Let us use as a benchmark the discussion around bits and atoms and say that innovation at a bit level is incremental, while innovation at an atomic level is fundamental. Is this paper innovative in bits or atoms? So far none of the examined technologies points to any atom, and therefore we have a collection of bits. But, what if most innovation is based upon bits and not upon atoms? Matt Ridley discusses this topic in his book *How Innovation Works*. He concludes that innovation in atoms is usually a collection of multiple innovations in bits. We hope that our work follows along this line of reasoning and it can set the stage for a paradigm shift as to how the AI and Legal-Tech world can jointly work on contract automation.

To conclude, this research article began by giving you a promise but by the end of it, we hope to have provided a real gift: a systematic way to study contract automation and to achieve the goal of iContracts.

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