Preventing disputes: preventive logic, law & technology

Stathis, G.

Chapter 2

Intelligent Contracts

The Chapter addresses RQ1, which reads:

> **RQ1:** *To what extent is it possible to develop an ontology that automates contracts with communications and risk data?*

Contract automation is a challenging topic within AI and LegalTech. From digitised contracts via smart contracts, we are heading towards iContracts. We will address the main challenge of iContracts: the handling of *communications* and *risk* data in contract automation. In the Chapter we *design* and *conceptualise* an iContract ontology. Our findings will validate the *conceptual expressiveness* of our ontology qualitatively and quantitatively. A brief discussion highlights the value of the ontology design and its application domains. The Chapter concludes by two observations: (1) the current method is innovative, and (2) further research is necessary for handling more complex use cases.

The current Chapter corresponds to the following two publications:

Stathis, G., Trantas, A., Biagioni, G., de Graaf, K. A., Adriaanse, J. A. A., and van den Herik, H. J. (2024). Designing an Intelligent Contract with Communications and Risk Data. *Springer Nature Computer Science (SNCS): Recent Trends on Agents and Artificial Intelligence*, 5(709). https://doi.org/10.1007/s42979-024-03021-x

Stathis, G., Trantas, A., Biagioni, G., van den Herik, H. J., Custers, B., Daniele, L., and Katsigiannis, T. (2023d). Towards a Foundation for Intelligent Contracts. *In the Proceedings of the 15th International Conference on Agents and Artificial Intelligence (ICAART)*, 2:87–98

2.1 Artificial Intelligence, Contracts and Innovation

The promise of a gift is different from the gift of a promise. Both are attractive. However, soon, the following questions will arise. Which one is better, or which one is always the best? Can we utilise an ontology to guide us in difficult decisions? Moreover, to what extent can AI involvement aid us?

While global media frequently advance statements discussing the replacement of humans by robots in the labour market, social confusion ensues [Larson, 2021]. The same holds for the legal world. So, the aim of our analysis 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 establish the technological foundations of iContracts.

2.1.1 Automation with Communications and Risk Data

While iContracts are advancing, they face two main challenges. They concern the *communication processes* preceding the drafting of contracts and the *risk analysis* of contracting clauses. The first challenge is the lack of standardised communication processes which increases the difficulty in deciphering *real communication* from *miscommunication* [1]. The second challenge is that the analysis of risk is not systematised for the purpose of handling automated computer processes. Such risk analysis adds heavy burdens on (1) the human expert who conducts the analysis as well as on (2) the contractors who may experience adverse consequences if risk is not managed well.

The two challenges are usually neglected in automation. During the communication, contracting parties exchange useful information that may affect the design of contracts. Typically, a legal expert (a) leverages the information and (b) analyses the risks that may derive by instinct only. For example, from the relevant legal rules [Stark, 2013] the expert drafts a contract by experience. As a result the communications and risk data often remain *implicit* in contract automation. A *mini-challenge* here is to make them *explicit*.

Such mini-challenges can contribute in making implicit communications and risk data explicit. In order to establish a solid foundation for such explicit expressions, we start by focussing on simple freelance agreement case studies. Gradually, this form of automation can be applied in more complex case studies, including for example enterprises or government contractors. So far, the

[1] A striking example of miscommunication in contracting regards, in construction for example, the ordering of wrong-sized material for the construction of a house, based on miscalculations from one of the parties. This can be avoided with the presence of standardised (automated) mechanisms along the contracting process. Ontology engineering can help clarify these mechanisms to a significant degree.

main alternative for freelancers or organisations is mostly involving physical contract interventions that are hardly scalable. The focus of our research aims at displaying how iContracts may benefit from small-scale challenges (mini-challenges) to future application in more complex environments.

2.1.2 Turning Implicit Data into Explicit Data

To handle the two challenges, our solution should begin at clarifying: *what type* of communication and risk data should be made explicit? This is difficult since communication and risk data are involved in all stages of the contracting process, which includes: (1) contract drafting, (2) contract execution and monitoring, as well as (3) contract dispute resolution. Provided that the initial communication and risk data analysed during stage (1) will affect later information in stage (2) and thereafter stage (3), we should begin our investigation with the stage (1).

Having selected a contracting process stage, it is also necessary to select a relevant contract category. Automating the legal communication and risk analysis has the potential to benefit, first, 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 neither omit the inclusion of any legal expert nor make an attempt to neglect any human expertise. At this moment we are cautious to note that automation cannot be immediately successful for all types of contracts. Therefore, our research focusses on a straightforward contracting case study.

To automate the workflow, a technological system should (1) process specific contract communications and risk data as input and (2) yield a contract as output. So our investigation should begin by identifying or defining such data. Due to temporal lack of literature for the specific types of automation, there are as yet no available data sources structured accordingly. 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. Obviously, the most prominent challenge is: *how the communication and risk analysis processes can be handled in a harmonised, scientific manner?*

2.1.3 Knowledge Representation with Ontology Engineering

To address both issues (communication and risk analysis), we utilise the power of ontology engineering (see Definition 1.6). Ontology engineering (1) studies the granular representation of the meaning and syntax of concepts, data and entities and their relations in a provided domain and (2) assists with representing knowledge in specific domains in a manner friendly for the computers to understand [Kendall and McGuinness, 2019]. Since the data concerning our research are implicit, ontology engineering is able to substantiate any automation effort on the basis of a clear conceptual framework.

The foundation for both communication and risk analysis, within the context of contracting, is legal knowledge. The implicit nature of analysis for both purposes gives rise to the need for explicit knowledge representation. Ontology engineering is a prominent method used in science to derive explicit knowledge representations [Grenon, 2008]. It can help us simplify and clarify the complexity of communications and risk analysis, especially in light of the uncertainty over the availability, or in rare cases the quality, of data.

Two alternatives to ontology engineering are briefly investigated. They are (1) unsupervised Machine Learning algorithms and (2) Relational Databases. Our experience was as follows. First, applying an unsupervised ML algorithm on available contract data is possible. However, structured data are hard to find, if not impossible, for the purpose of explicit communications and risk analysis. Second, we could have developed a relational-data model to demonstrate the connection among various data sources. Yet, such a model would be limited for our research purpose, since due to the implicit nature of the communications and risk analysis, the resultant data are not in agreement with the data from our literature search. Therefore, we have chosen ontology engineering for our investigations.

2.1.4 Chapter Motivation

Our interest in studying this multi-disciplinary topic originates from closely studying three observations. (1) *Preventing disputes* is more effective than resolving disputes. (2) *Legal risk technology* in larger organisations is often based on manual processes, where smaller organisations are rarely able to handle them. (3) *Legal risk management* is based on the outcome of communications on legal agreements between at least two parties.

2.1.5 Research Question 1

It has become clear that the formulation of an *ontology* can be a fitting method that helps the systematic study of our challenge. Making explicit the communication and risk data in contract automation should be investigated. The considerations above lead us to the following RQ1.

> **RQ1:** *To what extent is it possible to develop an ontology to automate contracts with communications and risk data?*

In our research we face two obstacles. First, so far, the inclusion of communications and risk data in automation is absent in existing LegalTech solutions.

This is straightforwardly validated by key word search on the largest LegalTech solutions database in the world: LegalComplex. Second, we start with the design of an ontology (called the Onassis Ontology) for contract automation which shows that automation based on communications and risk data is possible and is even essential for iContracts. The ontology is qualitatively *validated* by the application of a Knowledge Graph (KG) (see Figure 2.2, in Subsection 2.4.2) on a case study for freelance agreement (for definition of KG see Definition 2.1 [Ehrlinger and Wöß, 2016]) [2].

Definition 2.1 – ***Knowledge Graph***

A **knowledge graph** acquires and integrates information into an ontology and applies a reasoner to derive new knowledge.

Our ontology emphasises how communications and risk data contribute to the development of an *effective* and *responsible* contract automation, which reduces the need for the physical involvement of legal experts. To avoid any confusion, the Onassis Ontology is only used as a larger technological solution for contract automation, whereas its formal descriptions will be used to drive the automation at a later point, since the ontology in itself does not directly automate anything.

2.1.6 Chapter Structure

To answer RQ1, we structured the Chapter as follows. In Section 2.2, the relevant literature is described. Section 2.3 presents how we conduct key word search in the database for LegalTech solutions and how we design the ontology within the context of the case study. Then, Section 2.4 presents the database findings and applies the KG on the case study. Section 2.5 discusses the database findings as well as the ontology design and its applications. Finally, Section 2.6 answers the RQ1 and provides three chapter conclusions and three suggestions for further research.

2.2 Relevant Literature

The literature Section is structured as follows. Subsection 2.2.1 introduces the literature on contract automation solutions. Then, Subsection 2.2.2 elaborates on contract communication and risk literature. Thereafter, Subsection 2.2.3 discusses the state-of-the-art literature on iContracts. For a good understanding,

[2] We should note here that ontologies are closely interconnected with KGs since 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).

Subsection 2.2.4 presents the relevant ontology literature on contract automation. Finally, in Subsection 2.2.5 we provide a table showing the state-of-the-art and associated main pitfalls. We *do not* discuss in detail physical, digital or smart contracts in the literature, because they are only indirectly related to our research scope.

2.2.1 Contract Automation

In most jurisdictions around the world, contracts are defined as follows (see Definition 2.2 [Smits, 2017]).

*Definition 2.2 – **Contract***

A **contract** is a legally binding agreement, verbal or written.

For an agreement to be binding, certain requirements must be met. Those requirements are usually laid out in the contract law of the relevant jurisdiction, which typically also ensures that conflicts can be resolved through the court system of that jurisdiction. In general, contracts are governed by private law and in each jurisdiction there are well-defined rules for contracting. Typically, those rules may be substantially divergent.

The two largest online databases on available contract automation solutions are:

1. Stanford University's *Legaltechlist*[3], and
2. Legalcomplex's *Legalpioneer*[4].

The *Legaltechlist* is a strictly curated database while the *Legalpioneer* database is a more extensive database. At the time this research was conducted (May 2023), Stanford's website has a total of 2,094 results and Legalpioneer's website has 9,608 business cases archived. In these databases, the number of available contract automation solutions that are related to this research will be identified after a global inspection of the content of both databases. They should be related to our topic: iContracts. We decided to focus on identifying companies in *Legalpioneer* due to the larger amount of available data. The data are expected to support the importance of our research scope.

We contacted the owner of Legalpioneer, and after some investigation on our goal, we were given access to the results of the proprietary analytics tools of Legalcomplex. The tools included advanced search and analytics on the Legalpioneer data for identifying and analysing data with a higher degree of accuracy[5]. The database, however, does not include state-of-the-art solutions

[3] https://techindex.law.stanford.edu
[4] https://www.legalcomplex.com and https://www.legalpioneer.org/
[5] https://www.legalcomplex.org/

that have not reached the market or are yet to reach the market soon. A general trend observed is that contract automation solutions gather significant attention in the LegalTech innovation. Our research aims to help establish and clarify the percentage of the total contract automation solutions within the available LegalTech solutions (in May 2023).

2.2.2 Contract Communication and Risks

Most of the available literature on contract communication is focussed on *contract negotiations*. The word *communication* points in our context (seen in larger extent) to the way how contracting parties *should* talk with each other, in order to (1) gain a negotiation advantage, (2) reach an agreement and/or (3) avoid the escalation of conflicts. Here we remark once more that in our research, the word *communication* refers to the substantive information (obtained from negotiations) that is directly relevant for the design of a contract. The general trend of AI in this context focusses on the role of *chatbots* in intelligent automation [Anagnoste et al., 2021].

So far, in the literature referenced and in other literature, communication data are not connected with risk data, whatever the context of contracting automation may be. Still, the contract communication literature is sufficiently advanced to assist the management involved of relevant communication data, even for new purposes such as managing *legal* risk. Our research will support the clarification of the partitioning into percentages of contract automation solutions. For a proper understanding we provide a brief history.

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, Edward 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, Barton, 2006].

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[6]. The difference between preventive and proactive law is that the latter, apart from the preventive dimension, adds a new dimension, viz. the promotive dimension in terms

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

of good and desirable behaviour [Berger-Walliser, 2012]. Haapio is mostly concerned with the application of proactive law in contracts.

In 2010, she created a synergy between (1) *proactive law* (Haapio) and (2) and *law as a competitive advantage* (Siedel) [Siedel and Haapio, 2010]. As a consequence of this synergy, in 2013 they published the book *A Short Guide to Contract Risk* where they analyse contractual legal risks [Haapio and Siedel, 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 all complex legal language into clear language expressions and visualisations, so that contracts can be understood by everyone before legal problems arise [Berger-Walliser et al., 2017].

The most recent research of PPL focusses on smart contracts [Corrales et al., 2019b]. 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 *better understandable* and *accessible* for contractors [Corrales et al., 2019a, Barton et al., 2019]. Haapio often emphasises the importance of *design* for contracts, but this holds in particular for smart contracts [Hazard and Haapio, 2017].

In 2004, the academic Jon Iversen introduced *Legal Risk Management* [Iversen, 2004]. Then, in 2007, the academic Tobias Mahler discovered a difficulty in *defining legal risk* and *how diverse it is* [Mahler, 2007]. Following the introduction of a standard for compliance risk management by the International Organization for Standardization (ISO) in 2014 [Bleker and Hortensius, 2014], Mahler along with the academic Samson Esayas set out to systematically analyse and model compliance risk in 2015 [Esayas and Mahler, 2015]. Recently in 2020, ISO introduced the first Legal Risk Management (LRM) standard focussed exclusively on legal risk for organisations and defines *legal risk* as follows (see Definition 2.3 [ISO, 2020]).

Definition 2.3 – ***Legal Risk***

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

By building upon the literature of PPL our research will show how it is possible to develop an ontology for analysing and visualising contract risk. For a full understanding we provide a clear outline in Chapter 3.

2.2.3 Intelligent Contracts

The step from smart contracts to iContracts can only be performed when one is able to manage and prove milestones. On a macro level, applying the iContract technology in a complex legal situation unfolding in, for example, an energy project would require higher sophistication. Such a higher sophistication is examined under the aegis of *iContracts* [McNamara and Sepasgozar, 2021].

The field of iContract (1) will introduce a hybrid contract automation approach and (2) will consider the need for contract automation that corresponds to the complexities of reality, aiming at the transition of automation into a *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 most evidently under construction [McNamara and Sepasgozar, 2018], the more so since a high level of complexity drives the need for such innovation [McNamara, 2020]. 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] [7].

The iContracts literature is not sufficiently developed yet. That occurs for multiple reasons. One reason is that there is no widely adopted iContract solution in the market. Our research contributes towards this direction by showing the *design* of an iContract. Additional research limitations relate to end user adoption of iContracts. That is also caused (to a large degree) by the lack of available iContract solutions. One of our observations is that research on iContracts has decreased in the past two years. Potentially, it is because when the concept *iContracts* was initially highlighted, its development complexity was so large that it created confusion in research. Our investigations aim to clarify this confusion by offering to scientists an iContract "playground" (the Onassis Ontology) to experiment with practically applicable iContracts.

[7] A key value of iContracts is that they can leverage information from various data sources, including smart Internet of Things (IoT) sensors, for automated monitoring of contract data [McNamara and Sepasgozar, 2020]. IoT sensors are essential for the monitoring of contract data in complex industrial structures and benefit iContracts with automated data collection. The IoT applications in iContracts can range from environmental monitoring for CO2 emissions tracking, to quality control of machinery and compliant inventory management. It should be noted here that iContracts can be implemented in both centralised and decentralised systems [Deng and Li, 2019]. 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 freelance agreements it is harder to monitor a contract with sensors and manual effort is needed. Yet, the complexity of the contract overall is smaller and the execution process can be more manageable. In relation to construction, the complexity of the contract is much larger, with multiple sub-contractors involved. Despite the existence of IoT sensors and the higher degree of automated monitoring, the execution of contracts will be more cumbersome.

2.2.4 Contract Automation Ontologies

So far many ontologies have been applied in legal contexts (for reference see below), but not for the specific context of contract automation via *communication* and *risk* data. For a better understanding of the available literature, we provide five references:

- 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]
- for case recommendations [Dhani et al., 2021]

In relation to contract automation in general, ontologies have been used:

- for conceptualising contracting terms and promoting interoperability regarding concepts [García and Gil, 2008]
- for data exchanges for blockchain-based smart contracts [Kruijff and Weigand, 2017]

The last two publications do so on an *infological* (interpretation and meaning of data) and *datalogical-level* (raw data astructuring and processing). The ontologies have also been used to support the automation of public procurement processes[8]. Moreover, the ontologies have been exploited more generally, albeit at a higher level of abstraction, for:

- blockchain-based smart contracts [Zhou et al., 2020]
- other research concerning contracts [Kaltenboeck et al., 2022], and
- contract risk management [Wu, 2021].

To date (2023), the closest research on our subject is that of Legislate [9], where they use an ontology for *drafting* and *negotiating* contracts as well as representing *rights* and *obligations*. This happens behind closed doors as their Knowledge Graphs (KGs) [10] are protected by a patent on semantic document generation [11].

[8] http://contsem.unizar.es/def/sector-publico/pproc.html
[9] https://legislate.ai
[10] https://www.legislate.tech/post/knowledge-graphs-know-more-about-your-contracts
[11] United States Patent 11087219

In addition to all ten applications mentioned above, our research applies ontologies from the perspective of *communication* and *risk* data automation. Here we admit that the potential of applying ontologies in the legal domain may even reach the level of developing industry-wide interoperability standards. Obviously, they are similar to the ones that occurred in the financial industry via the Financial Industry Business Ontology (FIBO) [12].

In essence, our ontology contributes towards *five* important directions in relation to literature. First, it applies ontology engineering on a practically relevant *legal risk management* level. Second, it shows how it is possible to *connect communications and risk data* via an ontology. Third, it provides a *technological tool* to organisations interested in adopting contract automation solutions. Fourth, the ontology shows how it is possible to *make explicit* the usually *implicit communications* and *risk data* within the context of contract automation. Fifth, it offers a new working process to legal experts interested in *scaling the delivery* of their services with a higher degree of *effectivity* and *responsibility*.

2.2.5 State-of-the-Art

To summarise the literature review in two concepts we defined the (1) state-of-the-art in contract automation and its (2) main pitfalls on four relevant levels related to our research: (a) communications data, (b) risk data, (c) communications and risk data, as well as (d) ontology engineering. Table 2.1 shows four relevant points for the state-of-the-art (middle column) and its associated main pitfalls (right column) related to our research.

Below we summarise the four concepts. First, *Chatbots* are the most advanced way to manage communications data, however they are not trusted significantly by end users (in Chapter 4 we discuss this issue in greater detail [Stathis et al., 2023c]). Second, the *Bow-Tie Method* is the best available method to manage risk data, although its process is time-consuming and not widely adopted (we also discuss this matter in detail in Chapter 3 [Stathis et al., 2023b]. Third, only an *implicit connection* between communications and risk data is available; currently it is based on human analysis. Fourth, *contract data* is today applied by specific ontology engineering, which, due to the lack of explicit inclusion of communications and risk data, is limited.

2.3 Research Methodology

The research methodology consists of five phases. First we start with an analysis of Legalcomplex data which is based on key word search (Subsection 2.3.1).

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

Table 2.1: State-of-the-Art & Main Pitfalls

	State-of-the-Art	**Main Pitfall**
Communications Data	Chatbot	Low trustworthiness
Risk Data	Bow-Tie Method	Time-consuming
Communications and Risk Data	Implicit connection	Requires human analysis
Ontology Engineering	Contract Data	Limited and restricted data

Then, the methodology employs the stage of *determining* the specific case study (Subsection 2.3.2). Moreover, ontology engineering itself is introduced (Subsection 2.3.3), as well as its *design* and *conceptualisation* (Subsection 2.3.4) to arrive at its *validation* (Subsection 2.3.5).

2.3.1 Key Word Search

The goal of Key Word Search is to investigate the landscape of contract automation and comprehend the significance available solutions have paid on contract automation based on communications and risk data. To gather data we requested Legalcomplex to conduct key word search, with the expectation of identifying the available solutions of contract automation today. Legalcomplex has classified contract automation solutions into the following five categories:

1. Contract negotiation
2. Contract risk management
3. Contract drafting
4. Contract extraction
5. Contract management

Since they have classified *communications automation* as *negotiation automation*, the conducted search follows the relevant classification. More specifically we may state that, according to Legalcomplex, contract negotiation consists of *seven* steps. According to the definition, they are collections of:

1. Names
2. Dates
3. Amounts
4. Clauses
5. Signatures
6. Entity and Structure
7. Ownership and Conflict

Legalcomplex conducted key word search on four concepts: (1) *contract automation*, (2) *contract negotiation*, (3) *contract risk* and combined (4) *contract negotiation and risk*. According to the owner of Legalcomplex, they used their algorithm to obtain the totals. The key word search was determined by the following specific questions that we provided to Legalcomplex.

1. What is the total number of legaltech solutions?
2. What is the total number of contract automation solutions?
3. What is the total number of contract negotiation solutions?
4. What is the total number of contract risk management solutions?
5. What is the total number of solutions of contract automation that combine contract negotiation and contract risk management?

The limitations of the key word search based on the legalcomplex database are threefold. First, our search depends on Legalcomplex's classification, which is not cross-validated (at least note scientifically) with alternative classifications. As a result, potential concepts may be subject to ambiguity, synonyms and more generally terminological variations. Secondly, since Legalcomplex is a proprietary database, there is inherent bias included in its classification and data availability. Such bias may be due to (a) limitations in the understanding of context based on lack or preference of knowledge, (b) intentional or unintentional exclusion or inclusion of concepts or data that may be relevant to serve implicit (e.g., interest in a specific domain over another) or explicit purposes (e.g., commercial exploitation of database and reputation concerns) of the website owner, and (c) lack of granular semantic relevance due to potential skill, experience or resource limitations. Third, the key word search is limited to the available data included in the Legalcomplex platform.

2.3.2 Case Study

The case study concerns a contract regarding the provision of freelance services. The main question is how to determine the relevant items to reduce the contextual complexity of contract communication and risk analysis in such a way that they remain a valuable entity for our scientific investigation. A *freelance* agreement includes in general sufficient complexity. Usually it is recorded in 3 to 10 pages, whereas direct investment agreements, for example, may include up to 1000 page contract recommendations.

To get a proper agreement, a Non-Disclosure Agreement (NDA) was downloaded from the open-source legal documentation database of Capital Waters[13]

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

and adjusted to fit the needs of our case study. Thereafter, the focus was placed on applying the NDA agreement within the context of a freelancer agreement. There are various online contract templates that could help us in this case. They can be easily accessed online [14].

If the *automation* proves to be successful, gradually it can be applied to more complex types of contracts. Ideally, a Foreign Direct Investment (FDI) contract between an energy company and a government can also be automated in this way. Below we will explain why any freelancer contract is already complex for the current state-of-the-art technology.

2.3.3 Ontology Engineering

During a contract agreement a variety of explicit and implicit information is exchanged between stakeholders. *Explicit* information include contracting clauses, signatures and relevant documentation. *Implicit* information usually includes communication and risk analysis that begins before a contract is drafted. Our challenge is the question: how to make implicit information explicit?

To address this challenge, we perform a quick scan in the set of answers to the question: how can Data Science (DS) and AI help us? DS and AI present three available options related to (1) Machine Learning (ML), (2) Relational-Data Models (RDM) and (3) ontology engineering. The three options present different advantages and disadvantages to address our challenge.

First, let us consider a *Machine Learning* approach. When can an unsupervised ML algorithm be applied to any available contract data? The main obstacle is that such data are hard, so it might be impossible, to identify, find or obtain relevant data [Zeleznikow, 2023]. Second, a *Relational-Data Model* can be developed that handles various data sources and their connections. However, such a model may be limited for the application of AI [Paredaens et al., 2012, Walton, 2018]. Third, *ontology engineering* is an option. Ontologies show how it is possible to handle interconnected data sources with a great variety of data types, by creating semantic specifications (see further description in benefits Section below).

The concept of ontology engineering is taken for two reasons. (1) There is high conceptual complexity involved in making implicit data explicit. (2) We are facing multiple unknown information regarding the number and interconnected nature of data sources.

[14] See for example: `https://community.weagree.com/model-contracts/`.

Benefits and Limitations

Let us show how ontologies introduce benefits that are in particular helpful when dealing with our challenge, but also limitations that make our task harder.

Let us start with the benefits. Ontologies 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*.

For a proper characterisation we would like to emphasise the difference between an ontology and a relational database. The former can be seen to use "spoken-language" driven by a dictionary for communication while the latter uses "body-language" without a dictionary for communication. Moreover, an ontology is (1) extendable, (2) can support additional solutions and (3) may clarify limitations.

An ontology is able to serve as the backbone of an explainable *intelligent* platform where modern technologies are incorporated and tested [Sarker et al., 2020]. The core module of this platform will utilise modern models and techniques in the field of AI. In our research, the *value of the ontology* stems from its ability to support the implementation of communication and risk management in contract automation.

Now, let us also discuss some challenges. Ontology design can follow a relatively ambiguous and subjective process. Despite attempts to ground it with competency questions and concrete case studies, it may remain abstract. Moreover, an ontology may lack context sensitivity. That is especially the case for the legal domain, where a higher degree of linguistic sensitivity is required to deal with ambiguous legal language. Another aspect concerns limitations with reasoning and expressiveness capabilities, especially when concerned with legal reasoning that is complex in nature and in geopgraphic applications. Beyond such substantive challenges, an ontology may also present practical limitations in organising its deployment in a standardised manner, the time-consuming and costly development as well as difficulties with maintenance and updates.

2.3.4 Ontology Design and Conceptualisation

As mentioned above, ontology engineering is able to contribute in simplifying the complexity in automating communications and risk data during contracting. The ontology helps to:

1. *clarify* the relevant concepts involved in the automation,

2. *identify* relations among the concepts,

3. *inform* decision making by highlighting technological opportunities and risks,

4. *guide* the development of algorithms and collection of relevant data sources, and

5. *offer* a flexible and adjustable technological infrastructure to support contract automation.

To design an ontology, requirements need to be gathered. They are gathered based on the case study and a literature review. Taking into consideration the requirements, we arrived at the Onassis Ontology. It is visualised (1) in a simplified form in Figure 2.1 and (2) as a scientific "puzzle" in the Appendices (see Appendix 1C [15]) or in Github (with clear explanations), where all details are connected and visualised [16].

The ontology retraces the interactive process of *asking* ***questions*** and *giving* ***answers*** between a legal expert and a contractor (see Figure 2.1 right upper half) leading to the collection of relevant communication data. The data are processed by a legal expert who relates them to the relevant contract risks (see Figure 2.1 left upper side). The process that we aim to frame for automated methods (and that ultimately will lead to a formal contract) will result in an ontological conceptualisation (see Figure 2.1).

In the Onassis Ontology we see the starting points of the above-mentioned interactive process between 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 (in Figure 2.1 the "U" sign denotes that a predicate connects with two or more objects). By replying to the question, the contractor provides an answer. The answer includes information that can be extracted to update (1) one or more *variables* of a paragraph (see Figure 2.1 right under half). Each (2) *paragraph* is part of (3) a *section*, whereas multiple sections form (4) a *contract* (see Figure 2.1, lower half). The variable, paragraph, and section follow a numerical order within the constituent parts of 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 a number of agreements, which include not exclusively the offering, acceptance and the setting of expectations between the contractors (see Figure 2.1 red line in left half). An agreement here (see left upper

[15] https://github.com/onassisontology/onassisontology/blob/main/Appendices_PhD.pdf

[16] The Onassis Ontology 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

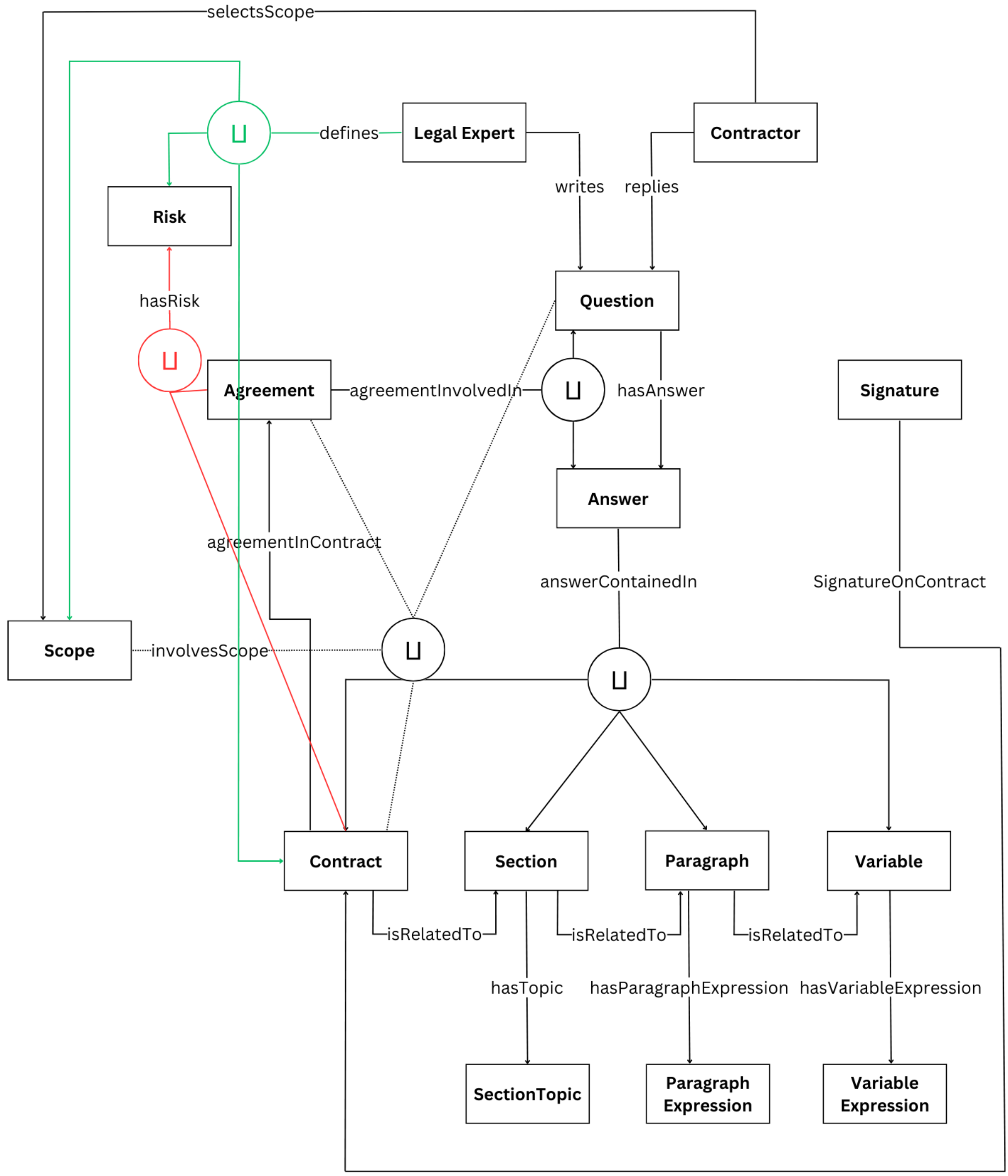

Figure 2.1: Onassis Ontology (Simplified)

half) 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 (follow the lines shown in Figure 2.1). The contract and agreement are always associated with a risk that is defined by the legal expert (see Figure 2.1 upper half). The risk, as well as all the additional constituent parts of the contract, can be reviewed by the contractor before signing the contract. The contractor is ultimately in charge to decide whether or not to enter into a legally binding agreement with another involved party (or parties).

The risk analysis is not provided in detail, because it is described in Chapter 3 and 4 [Stathis et al., 2023b, Stathis et al., 2023c]. In summary, the risk management extension, called the *Enriched Bow-Tie Method* [Stathis et al., 2023b] (not discussed here), helps a legal expert *analyse* and *visualise* contract risk.

2.3.5 Ontology Validation

The logical consistency of the ontology has been tested by launching the specialised reasoner Hermit 1.4.3.456 on sample data in the Protégé editor (for references and details see [17]). The use case employed is presented in the results.

In Chapter 5 we will show that the ontology is not only *validated* with the Knowledge Graph, but that it can also be *re-programmed* via a prototypical web application [Stathis et al., 2023a].

In particular, we will detail how the web application supports contractors and legal experts in (a) negotiating, (b) analysing risk and (c) preventing hazardous events, and finally in (d) drafting a contract according to the Onassis Ontology [Stathis et al., 2023a]. The Onassis Ontology (a *model / terminology*) is instantiated by a contract (*data / assertions*) [18]. The source code for the prototype web application is accessible via Github [19], including a user guide, screenshots of typical usage, operational and Docker hosting instructions to ensure replicability, and instantiated Onassis Ontology contract data created by application users.

[17] https://mvnrepository.com/artifact/net.sourceforge.owlapi/org.semanticweb.hermit/1.4.3.456

[18] An example of an Onassis Ontology-based contract data file created by contractors and legal experts is available on Github: https://github.com/onassisontology/icontracts-back-end/blob/main/example_iContract_ontology_data.ttl

[19] see https://github.com/onassisontology/icontracts-back-end and https://github.com/onassisontology/icontracts-front-end

2.4 Research Results

The results of our research are modest. The first result is an indication of its potential: *the percentage* of available contract automation *solutions* related to the scope of this research based on the Legalcomplex data (see Subsection 2.4.1). The second result is a confirmation that the KG works as a *validation mechanism* for the ontology (see Subsection 2.4.2).

2.4.1 Contract Automation Solutions

After the key word search in Legalcomplex the following four classes of solutions were traceable, viz. for (1) contract automation, for (2) contract automation based on communications data, for (3) contract automation based on risk data and for (4) contract automation based on communications and risk data. Below we specify them in numbers and percentages:

1. out of the total of 10,448 LegalTech solutions, 590 solutions (5.6 percent) focus on *contract automation*;

2. out of the contract automation solutions, 51 (8.6 percent) focus on *contract communications*;

3. out of the contract automation solutions, 50 (8.4 percent) focus on *contract risk*;

4. surprisingly (both for the researchers and owner of Legalcomplex) there was *no* solution focussing on both *contract communications and contract risk*.

Result (4) (no combination of communication and risk) was surprising for us (and possibly for the reader). The results indicate that despite the abundance of contract automation solutions, there is a significant omission for solutions which are focussed on communications *and* risk data analysis. It is an omission on both sides. It is now on our attention list.

Legalcomplex provided us also with the top ten solution results for each category of key word search. The top ten solutions result shows the ten most financially wealthy companies under each category. In order to understand the focus of each of the top solutions for each of the three categories with solutions, namely (1) contract automation, (2) contract communications and (3) contract risk, we now develop a new Table 2.2 below. The table is split into six columns, which are structured as follows.

Column 1. Contract automation solutions
Column 2. Contract automation solution applications
Column 3. Contract communications solutions

Column 4. Contract communications solution applications
Column 5. Contract risk solutions
Column 6. Contract risk solution applications

Table 2.2 shows that in contract automation industrial cloud is prevalent and that the space is diverse with applications in multiple areas from contract and project management to document and customer management. As for contract communications, again cloud is dominating although 4 solutions are focussing on contract management, showing the significance of communications for contract management. Then, as for contract risk, Third-Party Management is the primary application and a trend is observed to apply risk management in the financial and insurance domains with five solutions focussing on that direction.

2.4.2 Knowledge Graph

As mentioned in Section 2.2.4, the KG plays the role of validating the ontology design and visualisation by leveraging practical case studies and connecting data deriving from them with the designed ontology concepts. If the connection suffices to represent all relevant data in a case study, we may conclude that our ontology is well designed and conceptualised.

To validate the *coherency* of the ontology with the domain knowledge, we did run competency questions on the instance data that we structured via the vocabulary terms of the Onassis Ontology. The validation process displays the level of *expressiveness* of the vocabulary. For instance, the Onassis Ontology fully supports the use case scenario in Figure 2.2, which shows the KG. The scientific version of the KG visualisation is to be seen in the Appendices (see Appendix 1J [20]) or via the Github page (see the link in the footnote [21]).

Following the development of the Onassis Ontology based on the case study and the literature, we may conclude that the KG design (given in Figure 2.2 in a simplified format and on Github as a scientific "puzzle" [22]) indeed convincingly shows that the development of a KG is *possible*. The validation proof is by stepwise verifying that it is possible to add selected data points derived from any new case study to the ontology.

We explain Figure 2.2 [23] by a straightforward use-case scenario introducing two human beings, viz. Laura (a legal expert) and Atanasio (a contractor)

[20] https://github.com/onassisontology/onassisontology/blob/main/Appendices_PhD.pdf
[21] https://github.com/onassisontology/onassisontology
[22] https://github.com/onassisontology/onassisontology
[23] In the figure, individuals are represented as rectangles. Their associated datatype values are highlighted in blue. Relationships are represented as arrows. The KG follows the logic described in Figure 2.1, starting with the abstract level and following with the physical level. That is to say, once the legal expert has selected a scope and defined the risks and questions for an agreement,

Table 2.2: LegalTech Solutions Application Domains

Top	**Automation**	*Application*	**Communications**	*Application*	**Risk**	*Application*
1	Infor	Industry Cloud	Vlocity (Salesforce)	Cloud and Mobile Software	Aravo Solutions	Third-Party Management
2	DocuSign	eSignature	Pactum	Negotiations	Epoq	Legal Documents
3	Icertis	Contract Management	Robin AI	Contract Management	Powerlytics	Predictive Analytics
4	Seismic	Customer Management	Spendflo	SaaS Buying Optimisation	Intellinetics	Document Management
5	Workfront (Adobe)	Project Management	Trim	Bill Negotiations	Hypernative	Web3 Asset Protection
6	Snapdocs	eClosing	ParelyPro	Contract Management	Nayms	Insurance Marketplace
7	Ontra	Legal Operating System	Common Paper	Contract Management	Sparrow	Digital Asset Solutions
8	Coda	Document Management	Along	Customer Management	Insurdata	Geocoding Data Management
9	Onit	Legal Workflow	Contraktor	Contract Management	DocLogix	Document Management
10	AirSlate	Document Workflow	Valla	Workers Platform	Finch	Personal Finance

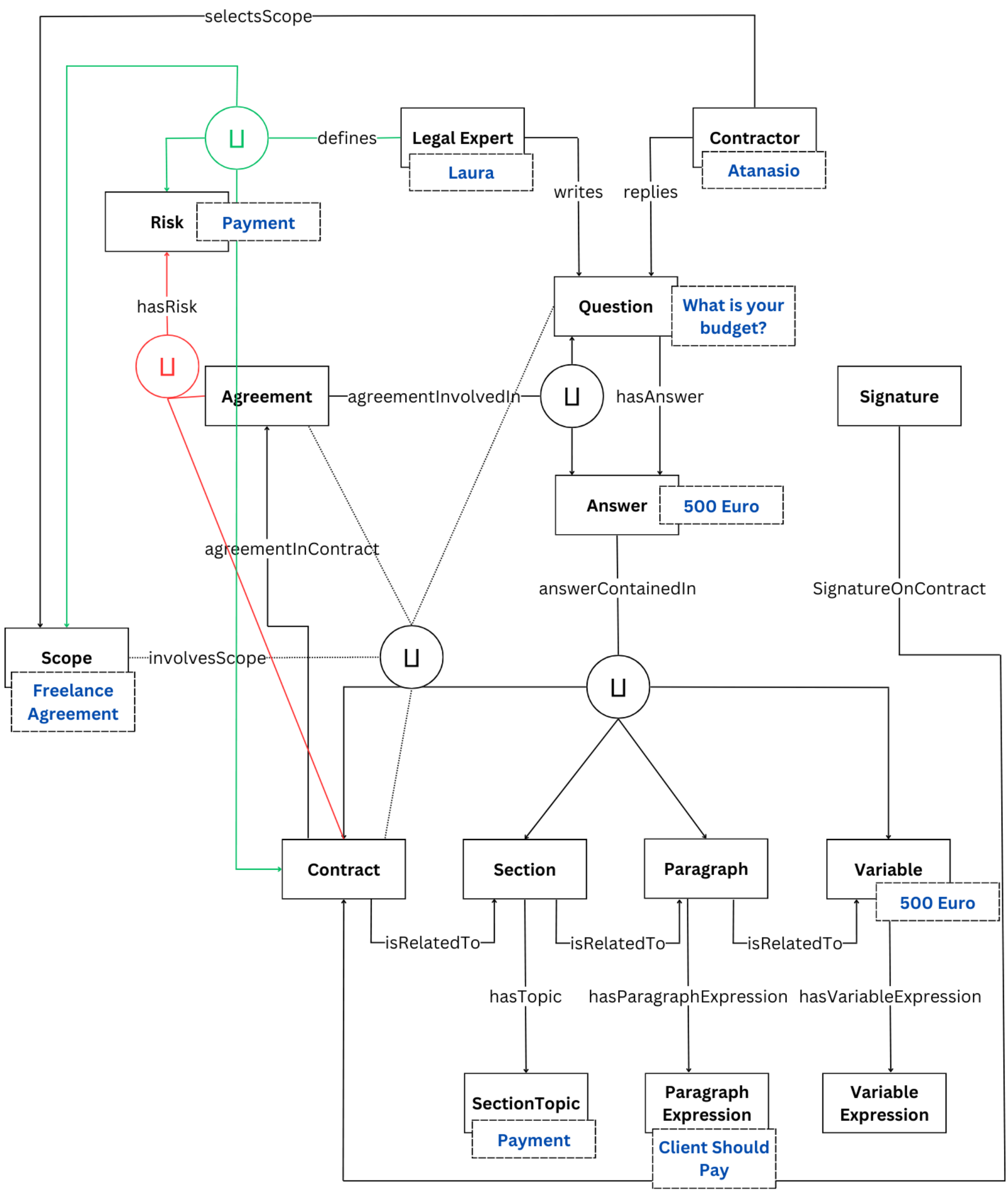

Figure 2.2: Onassis Ontology Knowledge Graph (Simplified)

the contractor is able to select a scope, answer the questions and the contents of the contract are updated as a result.

(all case-study data are visualised in blue in Figure 2.2). The use case scenario shows how the contractors provide answers to legal questions, out of which relevant variables are extracted to update a contract. Understanding the KG relies on the prior understanding of the Onassis Ontology, given that the KG follows the Ontology to model a specific use case to examine its validity.

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 and takes a freelance design agreement. The answer provided by Atanasio updates the *variable* uniquely identified by a *number*, *paragraph*, *section* and *contract*. 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, 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 completed the review of 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 use case scenario shows that our ontology structure is sufficient for the requirements of a freelance agreement. That is because, once a contract has been structured into sections and paragraphs the relevant variables can be identified that inform a Legal Expert as for the specific legal questions to be asked. We do mention freelance agreement specifically, given the relative simplicity of a freelance agreement compared to more complex agreements (i.e., FDI), of which the validation requires further experimentation. To further validate the sufficiency of the ontology structure, we introduce ten more use case scenarios in Table 2.3 [24].

Beyond these additional use case scenarios, additional experimentation is required, most importantly also in practice. The goal would be the discovery of outliers and potential non-integers as inputs to variables. At this point we find the ontology to be acceptable for this innovation stage, yet more experimentation is required.

[24] For efficiency purposes the variable is shown as the answer, even though in certain cases the variable is not necessarily the whole answer. Moreover, the Scope, Section and Parties remain the same

Table 2.3: Onassis Ontology Knowledge Graph Validation

Category	Question	Answer/Variable	Risk	Rule
Insurance	What is the number of your professional liability insurance?	12345	Insurance coverage	Freelancer must possess professional liability insurance
Payment Terms	What is your preferred payment method?	Final Delivery Payment	Delayed payments	Client should comply with the payment schedule
Confidentiality	How many years should confidential protection last	5	Information leak	Freelancer should maintain all information confidential
Intellectual Property	What type of intellectual property protection do you prefer	Full IP Protection	IP Ownership	Client reserves all IP rights
Scope Changes	What is your preferred way to be informed about potential scope changes	In writing	Delayed changes	Potential scope changes should be communicated explicitly
Delivery	What is the deadline for the delivery of your work in full?	22/5/2023	Project completion	Professional should deliver the necessary work by the stipulated deadline
Communication	What is your preferred communication channel?	Whatsapp	Lack of sufficient communication	The project communication should occur via the specified channels
Dispute Resolution	What jurisdiction should regulate the resolution of a potential dispute	Dutch Law	Dispute	All disputes should be resolved in accordance with the specified law
Termination	How should the parties communicate about the potential termination of the project	In writing	Project Termination	A project should be terminated in accordance with the specified procedure
Acceptance Criteria	What type of client rating is necessary to stipulate an acceptable deliverable	7 in scale from 1 to 10	Quality Control	A client should rate each deliverable from a scale of 1 to 10

2.5 Discussion

The discussion concentrates on analysing six issues. They are the following:

1. database findings (in 2.5.1)
2. ontology engineering implications (in 2.5.2)
3. AI applications (in 2.5.3)
4. contract automation implications (in 2.5.4)
5. insurance implications (in 2.5.5)
6. contract risk standardisation (in 2.5.6), and
7. research benefits (in 2.5.7)

2.5.1 Database Findings

The key word search results show that contract automation is a significant category of LegalTech solutions. Moreover, they show communications and risk data automations are each on its own important categories of contract automation solutions. Yet, the combined contract automation based on communication and risk data is so far not discussed in the literature. Without their connection we miss the opportunity to improve risk analysis based on quality communications data.

The data that 5.6 percent of the total LegalTech solutions focus on contract automation prove that the innovation in intelligent contracting is substantial. Yet, the data that zero percent of those contract automation solutions focus on the automation of communication *and* risk data, prove 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 how to address the *legal experts* as users and *not the contractors* as users. This means that most technology innovation in LegalTech focusses on the legal experts as the end users of legal innovation. One explanation is that LegalTech often requires legal knowledge and expertise, which is to be found with the legal experts and not with the contractors. When regarding the contract communication automation solutions we have to admit that 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.

2.5.2 Ontology Engineering Implications

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 we presented, this can be done by finding a middle ground between two sets of answers that the contractors have provided. On top of that, it is possible to incorporate additionally more data from other contractors and yield an average that represents the optimum expectations for both parties in the agreement. In this way, the risk between two parties for a dispute is minimised, as well as the potential consequential costs for both of them.

In summary, in this section we show the *value of the ontology* as a practical tool (A), the *conceptualisation of the semantics* (B), the *two levels of innovation* (C), the *relevance* of ontology engineering (D) and the *final validation* (E).

A: Ontology as a Practical Tool

We introduce an ontology to legal research, which represents how a legal expert is enabled by technology to handle contracts. Such a careful handling has not taken place so far, at least not according to the literature on the ontological representation level. Given that legal studies and practice involve the use of language as input and output, it is uncommon for the current research to treat legal reasoning procedures in a computationally friendly manner. In that respect, the ontology engineering is a new approach as it provides a *practical tool* for the legal world rather than providing just another theory. By practical tool we refer to a tool that can be used for the automation of a process that would otherwise require repetitive human labour. Such automation is innovative because it addresses two basic repetitive labour domains for legal experts today, namely the communications and risk data management, which today are often managed implicitly.

Furthermore, the ontology adds value for both smart contracts and iContracts, as it shows the extent to which certain processes can be programmed and those which cannot. It also helps clarify how far away we are from achieving the self-execution aim of iContracts. With the rise of LegalTech, the production of appropriate tools in academic research is becoming more common. Our research further illustrates the need for such practical tools.

B: Conceptualisation of Semantics

An innovative aspect of our ontology is that it has conceptualised a new domain, which benefits the world of ontology at a vocabulary level. In extension, this innovation is relevant for semantics, as it clarifies how the semantics of contract automation work at this level of conceptualisation. The ontology has been designed to minimise the appearance of unnecessary concepts. It represents—according to the workflow, the ontology, and the case study application—all relevant concepts and their properties for the generation of a contract based on *contract communication* and *risk data*. The Ontology shows how it is conceptually possible to generate a contract that includes risk management controls based on specific communication-based information extracted.

The end-value of the ontology should be examined by an experimental view on 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, meaning that the legal rules and risks involved in a contract are taken into consideration in a responsible 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. Chapters 3, 4 and 5 validate the two perspectives to a certain extent [Stathis et al., 2023c, Stathis et al., 2023b, Stathis et al., 2023a]. A future research direction is to test the efficiency of the ontology against further use cases, which entails its expansion. Towards such future research path, we will be able to create a richer taxonomy (by richer we refer to an ontology with larger amount of concepts and relations to comply with the requirements of more complex case studies) with external ontologies after testing the present ontology with other use cases.

C: Two Levels of Innovation

By making the ontology publicly available we achieve *two* levels of innovation. First, we stay connected with state-of-the-art developments since *feedback* based on iterations *increases*, as opposed to if this ontology would stay behind closed doors. Second, the selection of the *open-source model* makes the ontology more *accessible* to the public, contributing towards the acceleration of social innovation.

D: The Relevance of Ontology Engineering

The present research is relevant for four reasons. First, the Onassis Ontology provides a framework for managing risks in contract automation in a *trustworthy manner* as well as *preventing disputes*. Second, it paves the way for showing how it is possible to standardise contract drafting languages for contracting to become more interoperable. Third, it maximises 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. Fourth, we show the added value of ontology engineering against the direct application of an unsupervised ML or the development of a relational database in a research domain with implicit data.

E: The Validation

Our results validate that Onassis Ontology fits for plain cases and clauses. The larger the complexity of a case, the larger the amount of clause data that should be processed. With the validation of the ontology we show its potential value and how it can influence contract automation significantly (see also Chapter 5 [Stathis et al., 2023a]). Legal experts may no longer be involved physically in contracting processes between two or more parties; their interaction may only occur by using a computer. The contractors are able to: (1) obtain a contract more rapidly and (2) trust its content, without having to enter into extensive discussions in the contract formation phase. It is apparent that the Onassis Ontology significantly simplifies the contracting process. Moreover, due to structuring the ontology based on scientific reasoning and the collection of data, advanced analytics can be applied to extract nuanced information in the contracting process, which eventually prove invaluable for preventing disputes resulting from contracts or meta-data [Ha et al., 2021].

2.5.3 Artificial Intelligence 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 helps to make the algorithmic results *explainable* and *interpretable* [de Sousa Ribeiro and Leite, 2021] [25]. Still, in some cases involving data, such as risk data, an almost unavoidable bias is present and should be addressed. A first remedy might be, that before applying any algorithm potential biases should be addressed.

At this point, we mention three relevant AI applications that can be implemented with the ontology engineering technique to achieve a higher degree of automation. The reason why we refer to such AI Applications at this point and to such degree is to provide some initial guidance to follow up research as for the potential ways AI algorithms can be leveraged within the Onassis Ontology. Of course, further investigation is necessary to validate the implementation of these and additional AI applications on the Ontology.

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*.

[25] https://www.marktechpost.com/2023/03/11/understanding-explainable-ai-and-interpretable-ai/

Based upon these three risk-diminishing practices, we can see how ML algorithms can also be applied for classification or prediction. For example, we can *classify data for communication purposes* or how we can *predict the risk of a contract*.

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: (a) the traditional contracting process, (b) the programmed smart contract process, or (c) 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. Likewise, we can make better decisions on *when* and *how* to use an ML algorithm for classification or prediction purposes.

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 (1) examine which classes are the best candidates for co-dependency influencing such relations and (2) 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.

In relation to the field of AI and Law, the research sheds light into a practical application of AI in the rather complex field of legal data. Already, the field of AI and Law has a vast tradition especially in relation to such AI functionalities as text extraction, data extraction and text generation. Our approach shows how to improve the application of AI in legal domain in a more targeted way, especially for the purposes of contract automation based on communication and risk data.

2.5.4 Contract Automation Applications

In the same way that smart contracts began with cryptocurrencies and are now applied in more use cases, iContracts should gradually expand into more directions as well. In the present research, we have made a first attempt in showing how iContracts may apply in a freelance project. Moreover, we expect that further scientific examination of the iContracts concept should 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*. In fact, it is 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 will also improve. For example, in energy or financial industries, advanced risk frameworks are already applied and there is a higher degree of effectiveness in risk management relative to what can be controlled.

By connecting iContracts with realistic project execution, this higher effectiveness in contract execution can also be achieved. Here PPL, and in particular legal visualisation, can overcome 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 [26].

2.5.5 Insurance Applications

One of the main benefits for iContracts automation for complex projects relates to insurance premiums. In general, by having better risk predictions, insurance 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 (e.g., by being able to better measure contract risk for achieving policy-making). Indeed, in such projects where there are 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.

Insurance premiums are usually flexible in larger projects. In smaller projects they are calculated on the basis of general market standards. By calculating in greater detail the specific level of risk for each agreement, the opportunity rises to assign a tailored insurance premium for smaller projects. For instance, if an accident occurs (also known as ″occurrence″ in insurance) a claim is initiated. With iContracts it is possible (1) to locate the case of the occurrence faster and with a higher accuracy and (2) to determine the decision on a claim with a higher degree of validity.

2.5.6 Contract Risk Standardisation

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 can help as they can create the space for *responsible* risk management based on validated frameworks by abstracting and reducing repetitive workloads. Currently the proactiveness of contracts is not measured, so iContracts can also help with risk *quantification*. Chapter 3 [Stathis et al., 2023b] shows with the support of relevant literature how to move towards this direction.

[26]In relation to privacy and data security please refer to Chapter 9.

Our findings bring forward new research possibilities for technology-based dispute prevention by showing how it is possible to advance current legal risk management practices with legal risk technology. Risk standardisation is only one piece of a larger puzzle towards more effective risk management practices that can lead to the successful prevention of disputes, which includes compliance practices, a culture of legal risk management and the intelligent use of legal risk technologies.

2.5.7 Research Benefits

Designing an ontology to automate contracts based on communications and risk data is beneficial for (1) *technological*, (2) *trustworthiness*, and (3) *economic* reasons. First and foremost, the technology will increase the effectivity and scalability of contracting relative to state-of-the-art solutions; so that more contracts can be executed at a fraction of the time. Second, the focus on risk analysis helps increase stakeholder trustworthiness provided that legal risk is managed explicitly, leading to higher awareness and control over legal consequences to contractors as well as reducing the potential (human) mistakes by legal experts. Third, it is economically sensible given that more contracts can be executed at a fraction of the price, since less resources will be necessary for contracting on a procedural and human capital levels.

2.6 Chapter Conclusion

The Subsections below provide the answer to the RQ1 (in Subsection 2.6.1) and give further three research suggestions (in Subsection 2.6.2).

2.6.1 Answer to RQ1

The Chapter progresses the state-of-the-art in ontology engineering for the legal domain by providing an approach for contract automation based on communications and risk data. The RQ1 addressed in this research is:

> **RQ1:** *To what extent is it possible to develop an ontology to automate contracts with communications and risk data?*

The answer to the RQ1 is that defining an ontology to *automate* contracts based on communications and risk data to a level comparable with the best experts in the world *will be possible for adequate automation* as shown with the Onassis Ontology. To make the statement *adequate automation* better understandable, the three are actions are essential

1. to test extensively its validity,

2. to conduct further research to ensure that an adequate level of *trustworthiness* will be reached for any action the legal expert and contractors will be involved in, and

3. to keep a sharp eye on future developments that may have unexpected challenges with the automatically driven programs.

The three actions should happen beyond any research we have already conducted. The finding that *none* of contract automation solutions in the Legalcomplex database simultaneously focusses on both automating contract communications *and* risk data demonstrate a significant omission in the existing solutions. This omission justifies our scientific attention to the subject. The aims for the current research were (1) to bridge the gap between smart contracts and iContracts and (2) 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.

Our research on the market adoption of iContracts with the utilisation of communication and risk data is *in its early stages*. Still, our experiment with the Onassis Ontology as well as our parallel research on EBTO and the prototype of our ontology shows that there is sufficient potential to optimize the contracting process.

2.6.2 Three Research Suggestions

The key question at this point is: how to best move forward from here? 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 and (3) on the experimental validity of the KG in more complex case studies. Through this in-depth examination and validation, our ontology can be improved upon and expanded.

A step in conducting further research is aiming 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 (see for example ontology research on class correlation: [Hammar, 2014]).

To conclude, this Chapter 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.

CRediT Author Statement

Below I would like to give credit to all persons involved.

Stathis, G., Trantas, A., Biagioni, G., de Graaf, K. A., Adriaanse, J. A. A., and van den Herik, H. J. (2024). Designing an Intelligent Contract with Communications and Risk Data. *Springer Nature Computer Science (SNCS): Recent Trends on Agents and Artificial Intelligence*, 5(709). https://doi.org/10.1007/s42979-024-03021-x

Stathis, G.: Conceptualization, Methodology, Writing - Original Draft, Investigation, Visualization, Project Administration, Funding Acquisition, Writing - Review & Editing; **Trantas, A.**: Investigation, Writing - Original Draft, Writing - Review & Editing; **Biagioni, G.**: Validation, Formal Analysis, Investigation, Data Curation, Visualization, Writing - Original Draft, Writing - Review & Editing; **de Graaf, K.A.**: Software, Data Curation, Writing - Original Draft; **Adriaanse, J.A.A.**: Supervision; **van den Herik, H.J.**: Writing - Review & Editing, Supervision.

Stathis, G., Trantas, A., Biagioni, G., van den Herik, H. J., Custers, B., Daniele, L., and Katsigiannis, T. (2023d). Towards a Foundation for Intelligent Contracts. *In the Proceedings of the 15th International Conference on Agents and Artificial Intelligence (ICAART)*, 2:87–98

Stathis, G.: Conceptualization, Methodology, Writing - Original Draft, Investigation, Visualization, Project Administration, Funding Acquisition, Writing - Review & Editing; **Trantas, A.**: Investigation, Writing - Original Draft, Writing - Review & Editing; **Biagioni, G.**: Validation, Formal Analysis, Investigation, Data Curation, Visualization, Writing - Original Draft, Writing - Review & Editing; **van den Herik, H.J.**: Writing - Review & Editing, Supervision; **Custers, B.**: Writing - Review & Editing, Supervision; **Daniele, L.**: Resources, Writing - Review & Editing; **Katsigiannis, T.**: Writing - Review & Editing.