Risk Visualisation for Trustworthy Intelligent Contracts

Georgios Stathis
eLaw and Unit ISP
Leiden University and TNO
Leiden, the Netherlands
g.stathis@law.leidenuniv.nl

Athanasios Trantas
Unit ISP
TNO
the Hague, the Netherlands
thanasis.trantas@tno.nl

Giulia Biagioni
Unit ISP
TNO
the Hague, the Netherlands
giulia.biagioni@tno.nl

Jaap van den Herik
eLaw
Leiden University
Leiden, the Netherlands
h.j.van.den.herik@law.leidenuniv.nl

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ABSTRACT

Our research shows how contractor trustworthiness for Intelligent Contracts (iContracts) improves via the visualisation of risk. Traditionally, contractors relied on legal experts who conducted the analysis of risk and proposed contracting solutions. Currently, trustworthiness is still an open question concerning the state-of-the-art in user interfaces for contract automation, since the available interfaces do not present sufficient valuable information. As a result, the adoption of contract automation solutions is stagnating. To measure the impact on the trustworthiness at the end users side, we visualised legal risk for legal-question answering addressed to contracting parties. For this task, we developed an explorative survey that requested end users to rate how their trustworthiness level is different compared to (a) an empty user interface or (b) a legal expert physically discussing legal risks with them. The results show that the visualisation increases the trustworthiness significantly, even by an average of seven point nine (7,9), in a scale from one to ten (i.e., fully trustworthy). The discussion highlights the importance of risk analysis visualisation for user trustworthiness in iContracts and provides improvement suggestions. The conclusion is that end user trustworthiness improves with risk visualization.

INTRODUCTION

While the scientific interest regarding contract automation is accelerating, users are not adopting such solutions at the same pace. As with most technology innovations, several validation iterations are necessary. Here we remark that the difference between general technology innovation (for example in consumer internet offerings) and innovation in contract automation regards to a large extent *trust*, since an end-user action may have binding legal consequences.

Definition 1: **Trust** is a subjective estimate (by the truster) of the probability that the trustee will display the truster's preferred behaviour (Bauer 2019).

That behaviour is called the truster's *trustworthiness* (Bauer 2019). The underlying idea is that the implications of contractual agreements for end users have a high legal impact. Therefore, end users also need to trust the available technology to a significant extent for adopting contract innovation with the aim to avoid potential legal risks. Given the importance of legal risk in contract formation, the task to improve the communication of legal risk in contract automation for end users is a way to handle the trustworthiness issue. This is also the case for Intelligent Contracts (iContracts), which currently lie at the epicenter of the academic attention. Our hypothesis is that by visualising the risk analysis of a legal expert, in a user-friendly manner to contracting parties, the trustworthiness and subsequent user adoption of iContracts will be improved.

Obviously, a particular challenge affecting user trustworthiness for iContracts is the lack of sufficient understanding of legal risk involved in legal question-answering. Due to the binding effects of contracts, users remain still reluctant to trust technology when replacing legal experts. With the visualisation of contract risk, users may experience an improved understanding of the legal consequences during legal question-answering.

Recently, researchers have investigated the effects of improved risk visualisation for users in (1) LegalTech and contract automation, as well as in (2) additional industries, as listed in the literature (see Section 2). Even though the visualisation of risk is seriously examined, there is no academic study that shows the extent to which it deals with user trustworthiness. In particular, this is the case in the context of improved trustworthiness for legal question-answering for iContracts. Hence, we see that risk visualisation occurs mainly when using the bow-tie method as is done in several industries. There it is also the most advanced method. In our previous research, we have improved the bow-tie visualisation via the Enriched Bow-Tie Ontology (Stathis et al. 2023b). Currently, this innovation is still in its test phase with end users. To stress the importance, we will focus in this article on three issues, viz. (1) the impact of end user trustworthiness via risk visualisation, (2) the context of iContracts, and (3) the use of the Enriched Bow-tie Ontology for the visualisation of contract risk analysis.

The benefits of the research are clear for both the contracting parties as well as the end users and the legal experts. Contracting parties will be able to experience more

legal benefits and less substantial legal costs when using contract automation technology. Traditionally, the "outcome" of more legal benefits is expected from a legal expert who has physically assisted the contracting parties. Here, we note that legal experts will be able to tune their legal advice to multiple parties and use risk analytics to improve the impact of their advice for end users. So, the adoption of iContracts by end users and legal experts becomes more impactful as we take the nature of iContracts into consideration, which have a high focus on contract risk management.

The above-mentioned information lead us to the following **Research Question (RQ):** *To what extent is it possible to improve user trustworthiness for iContracts via the visualisation of risk during legal question-answering?*

Following this Introduction, to answer the RQ, we structured the paper into the Main Part and the Conclusion.

MAIN PART

The main part includes the literature (I), method of research (II), results of our research (III), and the discussion (IV).

I. Literature

Subsection A introduces literature on the user adoption of iContracts, Subsection B does the same for user adoption of contract automation. Subsection C presents sources on legal design thinking and user trustworthiness. Then, Subsection D discusses the state-of-the-art of legal design and Preventive/Proactive Law (PPL). Finally, Subsection E introduces sources on the visualization of the bow-tie method for improved trustworthiness. Regrettably, this section does not present an exhaustive literature list on the topics of iContracts, PPL and the bow-tie method as our previous work can be consulted (Stathis et al. 2023a and Stathis et al. 2023b).

A. User Adoption of iContracts

A literature search concerning user adoption of iContracts shows that there is only limited academic research investigating this subject. The little there is concludes that, even though a certain end user desire for the digitisation of forming contracts exists, the readiness of users for such disruptive change is unknown, (see McNamara and Sepasgozar 2020). These authors have investigated the subject of user acceptance. They highlighted the disconnection between academic efforts and the industrial adoption of iContracts, with user acceptance being one of the main challenges for adoption (McNamara and Sepasgozar 2021).

B. User Adoption of Contract Automation

Most literature work on user adoption relates to smart contracts such as contract automation solutions. Two issues, user-friendliness and the visualisation of legal obligations in smart contracts, are vital for the adoption of smart contracts (Ullah and Al-Turjman 2021). Still, not all users are willing to adopt this technology. The adoption curve is currently determined by prioritising early adopters (Badi et al. 2021). Three factors, viz. (1) perceived financial costs, (2) facilitating conditions, and (3) trust and readiness, influence perceived usefulness and ease of use (Chaveesuk 2020). Most importantly, there are administrative risks that may affect the adoption of smart contracts, including the regulatory change, the lack of sufficient legal planning, and the lack of dispute resolution mechanisms as discussed by (Gurgun and Koc 2022).

Beyond the specific use of contract automation solutions, Acemoglu et al. 2007 conducted an economic analysis of contract technology. They found in multi-stakeholder relationships that forming contracts is central to the successful completion of a project, but that the relative contractual incompleteness by a stakeholder leads to generally lower levels of contractual technology adoption.

Returning to risk aversion, we found an interesting study conducted on Chinese farmers (Mao et al. 2019). It shows that the higher the risk aversion of a farmer, the less likely it is for them to adopt technology. However, when specific contractual terms that reduce risk are included in contracts and understood by the farmers their adoption rate increases. A first finding is that farmers' risk attitudes and risk perceptions play an essential role in shaping risk management strategies to address risks and uncertainties (Pham et al. 2021). The same analogy can be made for the case of a contracting party as an end-user concerning iContracts, irrespective of their professional background.

C. Legal Design Thinking and User Trustworthiness

Central to the delivery of legal services is the concept of *legal risk*. Studies have shown that legal risk analysis is flawed, often leading to poor predictability. That is one of the main reasons why smart contracts have increased in adoption, viz. due to the higher trust they bring (Kisser et al. 2008). On the same line of reasoning, Fraser and Roberge proposed *legal design thinking* as a method for the re-evaluation of value and predictability (Fraser and Roberge 2016). Even though the literature highlights the need for risk prevention solutions, there is a lack of practical solutions. At this point, Yankovskiy supports that attention should be drawn to the fact that clients need an improved view of legal risk (Yankovskiy 2019). In the meantime, beyond the focus on risk, *design thinking* should also pay attention helping clients to make improved business decisions (Sainz 2020).

D. Legal Design Thinking and Preventive/Proactive Law

The research by Haapio addresses the connection of legal design with Preventive/Proactive Law (PPL) (Rossi and Haapio 2019). PPL researchers support the notion that improved legal visualisation techniques are necessary in the legal industry. Barton reinforces that notion by stating that the emerging information culture is largely compatible with the assumptions underlying PPL (Barton 2016). Barton's recent research seeks to identify design methods, such as simplification and visualisation, for using the emerging technology to help legal systems function better in the information age (Barton et al. 2016). Barton has ventured the proactive law movement, such as suggested by Haapio, to solve some of those design challenges (Berger-Walliser et al. 2017). Haapio focuses on the field of visual law and is in fact stimulating a design revolution (Corrales et al. 2019). The reason behind the ideas is that they are driven by the market (McLachlan and Webley 2021). The most advanced method

thus far for risk visualisation is the bow-tie method, and our research showed how it can be enriched for higher impact (Stathis et al. 2023). In this respect, Haapio posits that with risk visualisation the clarity of contracts improves (Haapio 2011).

E. Bow-Tie Visualisation for Improved Trustworthiness

The literature on bow-tie visualisation for improved user trustworthiness in contract automation and LegalTech is limited (Stathis et al. 2023). The bow-tie method has mostly been implemented as a method for increasing user trustworthiness in other domains. So far, most academic research concentrates on risk visualisation via the bow-tie method (the managers of risks being the end users) (Book 2012). This approach is the equivalent of the legal expert in the Onassis Ontology. Subsequent research highlights the benefits of visualising the bow-tie method for multi-stakeholder environments (Gerkensmeier and Ratter 2018). Luhmann argues that risks are mental constructs which are bounded and influenced by perception (Luhmann 2017). Hence, risk management and bow-tie analysis should be subject to a continuous social discourse (Gerkensmeier and Ratter 2018). Thus far, the current research supports the bow-tie as the most influential method of visualising risk in a multi-stakeholder environment according to (Gerkensmeier and Ratter 2018) and (Bernsmed 2018). The importance of risk communication to stakeholders is supported by additional academic research (Gerstenberger 2013).

II. Method of Research

This section presents the methodology of our research. The methodology concerns three main topics: (A) the introduction of the case study, (B) the application of the previously developed Enriched Bow-Tie Ontology visualisation (Stathis et al. 2023), and (C) the development of an explorative user survey measuring the extent to which the visualisation impacts user trustworthiness. The survey contributes to measuring the improvement in user trustworthiness based on the visualization of the Enriched Bow-tie Ontology.

A. Case Study on Payment Risk

The case study of our research focuses on representing payment risk related to legal question-answering for a simplified freelance agreement. The legal questions are addressed to freelancers. The most common legal questions freelancers receive in relation to payment risk, concern price expectations and milestone or payment planning. The case study facilitates the definition of the scope of both the visualisation and survey.

B. Enriched Bow-Tie Ontology Visualisation

In our representation of the payment risk, the legal expert is responsible for conducting the contract risk management process (Stathis et al. 2023b). In (Stathis et al. 2023b), we developed the Enriched Bow-Tie Ontology, which includes also a method of analysing the Enriched Bow-Tie Ontology from the point of view of the legal expert. Once the legal expert has completed the analysis, it is possible to present it to the end-user, in the form of legal question-answering.

C. Explorative Survey

The purpose of our explorative user survey is to measure the level of end user trust for a contract during legal question-answering, after the risk has been visualised. It is an explorative survey having the first of it's kind in literature. The survey aims at gathering an introductory understanding of end user trustworthiness.

The survey takes into consideration background information about users in order to reduce bias by gathering survey participants with diverse backgrounds. Each user is introduced to the legal question-answering context. The theme of the contract places the participant into a freelancer's position interested in signing a contract to provide services to one of their clients. The main risk they are facing is payment risk. Before they answer any question, their replies include a level of risk (higher-middle-lower) and a prompt to consult the visualisation of associated risks is presented. The risk analysis is visualised next to the questions.

The users are asked to assume a scale from 1 to 10, whereas 1 refers to a list of questions without the visual risk representation, and 10 to a list of questions with a legal expert explaining the associated risks to each guest extensively as the ultimate source of trustworthiness. Then, the users are asked to rate from 1 to 10 the perceived trustworthiness of the risk visualisation accompanying the questions. We provide a tailored definition of trustworthiness, based on the definition of trust provided in the introduction (Section 1).

Definition 2: **Trustworthy**, within the context of this survey, is the level of trust a contractor feels towards a user interface or a legal expert when answering legal questions related to their legal rights and obligations.

Moreover, the survey provides participants with secondary explorative questions investigating their productivity, anxiety, satisfaction and likelihood of referral levels. The survey also requests the provision of qualitative feedback.

III. Results

This section presents the results of our research. The results concern (A) the Enriched Bow-Tie Ontology visualisation, and (B) the explorative survey results.

A. Enriched Bow-Tie Ontology Visualisation

Acting as the legal expert, we conducted the contract risk analysis based on the enriched bow-tie ontology visualisation for the payment risk. Taking into consideration the risk of *no payment* as the potential hazardous event, is the start of our analysis. First, we identified potential causes, which included: (a) lack of deadline, (b) quality objection, (c) payment default, and (d) lack of budget. Second, for each cause we designed a proactive control, namely: (a) timeline, (b) quality control, (c) payment plan, and (d) budget screenshot. Third, we identified a consequence which was: (a) less monetary availability. Fourth, we identified reactive controls, which were: (a) stop service, and (b) pause service. Fifth, on the available data we assigned a probability number of 0.7 to the hazardous event occurring (blog.freelancersunion.org). Sixth, we assigned an impact number of 0.9 due to the severity of the hazardous event for a freelancer. Seventh, we concluded that the level of

risk is high, at 0.6. The connection among the different data points identified during the analysis is as follows. The hazardous event has cause and proactive controls, whereas the cause is contained by proactive controls. Moreover, the hazardous event has a consequence and reactive controls, whereas the consequence is contained by reactive controls. In addition, the hazardous event has a *probability*, which is based on a source, as well as an *impact* which affects an agent, and cumulatively the result lands in a specific level of risk. The visualisation can be accessed via the Onassis Ontology GitHub repository (www.github.com/onassisontology)

B. Explorative Survey Results

The survey collected 25 replies, based upon which an average score of seven point nine (7.9) was given to the visualisation representation, placing it on the scale of significantly trustworthy. Out of the twenty five replies, twenty two of them reported a score of seven or higher, while there were two outlier replies that assigned a number below six. The number was consistent for groups of users which originated from divergent backgrounds. Users with different backgrounds "averaged" rather similar scores. Finally, the participants rated that their productivity level increases by seven point five (7.5), their anxiety level decreases by seven point seven (7.7), their satisfaction level increases by seven point nine (7.9) and their referral likelihood is eight point nine (8.9).

IV. Discussion

The discussion concentrates on examining the research consequences for (A) user trustworthiness and (B) the risk visualisation from an end user perspective.

A. User Trustworthiness

The average trustworthiness score provided by survey participants was seven point nine out of ten. The score demonstrates that end users exhibit a high average level of trust towards risk visualisation for legal question-answering.

The risk visualisation is useful for access to justice concerns. It is particularly helpful for groups of people who find it challenging to pay lawyers. Moreover, it is useful for users who have little professional experience and prefer to know the risks rather than not to know. The risk visualisation is also helpful for people with low legal education, who may be prone to committing unnecessary legal mistakes.

In relation to the legal expert conducting the risk analysis there are legal analysis limitations. The trust of end users on the risk visualisation depends on the legal expert doing the analysis in the back-end or as a participant stated "on the intermediary handling the contact" who should be highly credible. As a survey participant expressed, lawyers may remain sceptical even with risk visualisation due to the nature of their job. Another survey participant expressed concerns as to how the legal expert is able to identify and take into consideration the unique risks that end users might be facing since it is highly depended on a per case basis. A survey participant suggested they might seek additional risk protection, despite the already detailed analysis of risk, in order to achieve higher protection. In general, most survey participants found risk visualisation to significantly improve their work as it is evident by the scoring of the secondary questions that were focused on their work and psychology.

However, it is vital to provide criticism, too, for the risk visualisation. Somes users may still prefer legal experts, even if they assigned high survey scores, as (1) they themselves lack time for performing the task, (2) they do not feel they can trust a graph over a human expert, or (3) they also have sufficient budget to hire lawyers. Not all users are expected to find usefulness in the risk visualisation, as also seen by the two outlier survey scores. The visualisation may be perceived as simplistic and a legal expert may still be perceived as significantly more trustworthy than a graph. That is mainly because in cases where a question or another matter is not predicted in the visualisation, a legal expert can provide an immediate answer.

B. Visualisation

The survey was also useful for (1) extracting information in relation to the enriched bow-tie visualisation and (2) for how the entities relate to each other. The comments focused on the conceptualisation and the use of the bow-tie analysis as well as the visualisation, even though optimising the visualisation was beyond the scope of this research.

Survey participants claimed that eventually the visualisation can be utilised for practical contracting, yet they were uncertain whether this type of visualisation fits every scenario. A user, requested for a clearer and perhaps easier visualisation of risk to achieve higher understandability for non-legal experts. Moreover, a user questioned how the visualisation changes, depending on the fluctuations in the selection of answers or during the contract execution phase.

As for the bow-tie analysis, users found the analysis aspect of the bow-tie detailed. A user with a legal background expressed that the analysis could be extended with more information for a greater level of protection. Another user found the analysis to be assumptive. Whatever the case, users found the analysis sufficiently secure and trustworthy.

Even though we are testing the conceptualisation and not the visualisation *per se*, some users also provided useful feedback in that direction. A participant supported the need for user experience improvements regarding the visual representation, introducing an idea for dynamically adjustable user interface changes depending on personalized options.

CONCLUSION

The RQ of this research is: *To what extent is it possible to improve user trustworthiness for iContracts via the visualisation of risk during legal question-answering?*

The answer to the RQ is that user trustworthiness can be improved to the extent that the visualisation of risk is sufficiently explainable for end-users. We measured it by a practical test and found a reward factor of seven point nine (in a scale from one to ten) based on risk explanation via the use of the Enriched Bow-Tie Ontology. There is, still, sufficient space for an increased trustworthiness by further improving *the risk visualisation from the users' perspective*. Beyond the positive impact on trustworthiness, end users found added benefits to their levels of productiviy, anxiety and satisfaction, motivating them to refer this way of working to their peers. Finally, we remark that the reason for the outlier scores mostly relates to personal user expectations.

At the end we reiterate that our research is novel in at least four areas. First of all, it clarifies how it is possible to visualise the Enriched Bow-Tie Ontology. Second, it adds the perspective of risk visualisation to the user-friendliness and trustworthiness discussion on contract automation domain. Third, it specifically shows how risk visualisation can improve the trustworthiness of the iContracts domain. Fourth, it demonstrates how it is possible to measure user reactions from divergent user backgrounds, with an explorative survey. In relation to further research, we are interested in conducting a larger scale survey to achieve higher statistical significance and also to implement the Enriched Bow-Tie Ontology in larger case studies to examine practical application matters.

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