

# An Intelligent Mediation Platform for Smart Contracts in Blockchain

Irene Kafeza<sup>1</sup>

<sup>1</sup>Online faculty, University of Liverpool

## Abstract

Smart contracts are blockchain contracts which are self-enforced and self-executed. The concept of self-execution highly relates to an alternative system of justice rather than the traditional court system. Thus, the smart contracts shift the concept of justice established by the state to an alternative form of justice which can be termed user self-controlled justice. Formal definitions as well as working conditions of the latter concept should be developed if an innovative and decentralized environment operating on this type of justice is to be deployed. Additionally, a key factor of the legal framework and regulatory environment is the trust from interested parties. Thus, if conflicts arise during smart contract formulation or execution, then the several parameters influencing mediation process should be objectively addressed. Underlying this work is the argument that dispute resolution services in general and mediation in particular should operate not only under well-established regulatory rules but also under rules pertaining to the behaviour of the parties involved since automation can contribute to self-determination based on values and norms of said parties. We propose a system architecture for smart contracts where the mediation process incorporates functional aspects such as previous related cases, visualization options, and legal context, but also behavioral ones such as emotional entity similarity and digital trust.

## Keywords

Smart contracts, contract conflict resolution, motivation theory, digital trust, expected gain

## 1. Introduction

Technology advances have changed the way legal services are delivered. The changes do not include only the way courts have been organised but also the introduction of innovative dispute resolution mechanisms. Alternative dispute resolution provides businesses with a fast and economical way to resolve a dispute and this is especially effective for international cases. Although there is an increased worldwide demand for alternative dispute resolution solutions, the existing framework is not as effective as it would be expected since it does not manage to persuade for trustworthy solutions. Therefore, there is a drawback in the provision of digital dispute resolution services, which is the principal motivation for this work. Specifically, this paper will deal with a mediation procedure and the parameters that make this process quite efficient in the smart contracts ecosystem.

In the currently prevalent neoclassical economic theory trust in third parties is irrational. Therefore, it may well be assumed that in a smart contract environment there can be no trust in general as almost by definition transactions take place automatically between unrelated parties. Moreover, considering that such transactions can naturally involve entities of different business cultures and practices in various geographic locations, the issue

of trust becomes harder to address. Consequently, the online mediation process becomes more challenging.

When parties involved in smart contracts require a dispute be resolved, the Mediator must ensure that the legal interests of all parties and the related parameters will be considered in the outcome. As mentioned in [1] clients consider neutrality, speed, confidentiality, process flexibility, reasonable cost, a wide spectrum in the choice of mediators, and clarity in rules and procedures to be the main factors for their choice for mediation. To identify and establish the framework that effectively solves the disputes the following principles should be considered:

- Confidentiality, neutrality, and impartiality should be integral parts of said mechanism.
- The self-determination of the parties should be ensured throughout the contract execution.
- Values upon self-determination include dignity, respect, equality, and privacy.
- The self-determination principle overturns the traditional principles of mediation.
- Parties feeling that they have determined the outcome and not a third party.

Using artificial intelligence (AI) to incorporate the above principles into an automated platform is challenging. In this paper we will describe how these human related aspects can be partially addressed using an automated mediation platform. This paper is structured as follows. Section 2 presents the recent scientific literature in smart contracts and proof mechanisms. In section 3 we describe the process of mediation as an alternative

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I.Kafeza@liverpool.ac.uk (I. Kafeza)



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dispute resolution mechanism. Thus, we provide a basic understand of the particular requirement of such a process. In section 4 we propose a system architecture that will enable automated mediation. At the end in section 5 we conclude this work and discuss future directions. It should be highlighted that throughout the text the terms *parties* or *parties involved* refer to the entities participating to the formulation or execution of a smart contract.

## 2. Previous Work

Smart contracts are increasingly becoming an integral part of digital world [2][3] and constitute a prime example of disruptive technology [4][5]. In [6] the authors analyze legal issues associated with the application of existing contract law provisions to so-called smart contracts, while in [7] the authors examine smart contracts from the perspective of digital platforms. They conclude that at least in some cases smart contracts can create legally binding rights and obligations to their parties [8][9]. To this end various dispute resolutions mechanisms are proposed [10], whereas design principles for them are given in [11]. Ethical considerations for legal blockchains are investigated in [12], enforceability aspects in [13], the effect on contract formulation [14], and the mentality of dispute resolution in [15].

The proof mechanisms of various blockchain stacks are the focus of [16]. Smart contracts operate in conjunction with blockchain stack technology [17] to create an efficient and effective framework [18]. The distinction between imperative and declarative smart contracts is exploited in [19]. Already smart contracts have been applied to digital certificates [20], remote patient examination and monitoring in digital healthcare [21], supply chain and logistics administration [22], and various cryptocurrencies such as Ether [23], while academic research places heavy emphasis on other fields as well [24]. Blockchain security considerations are investigated in [25] as well as in [26], whereas a penetration test framework is described in [27]. An overview of blockchain applications is given in [28]. In [29], the authors describe a platform where agents subscribing in a given common platform are creating and executing contracts. The evolution of blockchain technology that enables transparency in contract execution eliminating third parties, has provided a new dimension to the problem of automated contracting. In [30] the authors propose a system architecture and have implemented an architecture for deploying smart contracts in blockchain.

The problem of trust on online environments have been discussed in Web trust [31] as well as in the context of blockchain stacks [32]. In recent work [33] the authors propose the combination of blockchain technology and multiagent systems for building trust in agent

interactions. The trust in blockchain stacks from a legal perspective is discussed among others in [34], especially in the emerging field of transactional law [35]. Psychological aspects reinforcing trust for online dispute resolution in blockchains are examined in [36], e-governance [37], and for cryptocurrency purchases in [38].

## 3. Alternative Dispute Resolution-Meditation

Central to this work is the concept of alternative dispute resolution (ADR) explained in definition 1. ADR lays the groundwork for legally acceptable conflict management in general and digital dispute resolution in particular including special smart contract clauses.

### **Definition 1 (Alternative dispute resolution).**

*Alternative dispute resolution involves and refers to a variety of processes which are used as alternatives of the traditional court resolution system.*

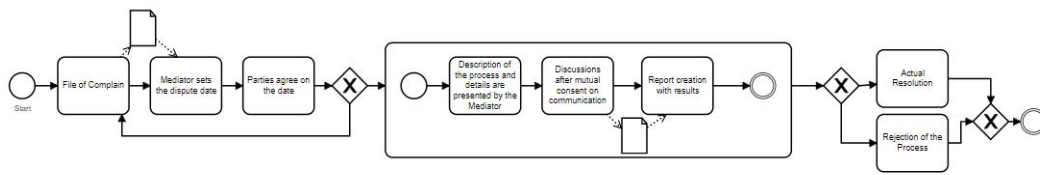
ADR can take several alternative forms which are distinct from each other in terms of flexibility, the role of any third parties, and whether the outcome is binding. The ADR scale typically includes the following options:

- Negotiation.
- Facilitation.
- Arbitration.
- Mediation.

In practice ADR can be realized a number of ways. In the context of electronic transactions, e-commerce, and smart contracts ADR takes the form of online dispute resolution (ODR) of definition 2.

**Definition 2 (Online dispute resolution).** *ADR conducted online is referred to as online dispute resolution and includes a range of methods from simple message exchange to sophisticated software applications.*

All forms of ADR including mediation frequently involve a set of standardized steps shown in figure 1. Initially, a party files a formal complaint to a third external provider, namely the mediator. Then the mediator ensures the parties involved have been notified about the complaint and sets a date for the actual dispute resolution process. At the specified date the parties meet physically or virtually and with the mediator acting as the facilitator they attempt to find a solution. During the discussion the mediator first explains to the parties the procedure, their role, and the role of each party. It is paramount the clarification that the mediation is only a discussion facilitator and not a judge. The mediator also explains the standards of confidentiality, neutrality,



**Figure 1:** Mediation process flow

and independence to be adhered to as well as the general principles such as fairness and equality governing the procedure. Furthermore, the mediator enumerates the particular characteristics of the mediation process and the effect and enforceability of their agreement in case one is reached. Once these topics have been clarified, the process begins. The discussion between the parties is based on their consent to communicate with each other and the enforcement of the result is also based on their consent to enforce it. In fact, the enforceability is one of the main differences of the mediation from the arbitration as in the latter case an arbitration award has by itself a binding effect.

The mediation process introduces the idea of a facilitator party, namely an entity that will assist in finding a mutually accepted solution. This is a step further than traditional negotiation since the parties negotiate on their own. Involved parties expect the facilitator to help the negotiation process and even propose a solution. Moreover, it is of paramount importance for the facilitator to be trusted by these parties. As a rule, the harder the conflict severity, then less obvious the solution is. In mediation the third party has no authority to impose a settlement.

As mentioned, the mediation process is straightforward and simple. A third party chosen by the parties' function as a facilitator when they meet to discuss and attempt to solve their dispute. The mediation process is based on the consensus and its enforcement is based on the party's acceptability of the outcome. Thus, the central person in the mediation process is the mediator. He is a facilitator whose main responsibility is to create the environment where the parties can discuss about their issues and try to find a workable solution for all of them. The mediator needs to have some qualities in order to successfully perform the assigned role.

The EU Directive on Mediation recognized the importance of the role of mediators and in order to ensure the quality of mediation encourages the development of voluntary codes of conduct by mediators and the development of other quality control mechanisms. The European Code of Conduct for Mediators also sets some voluntary rules which serve as guidelines for effective mediation services. In the US the Model Standards for Mediation also

supported the facilitative mediation and focused on the parties' self-determination.

The US legislation raised concerns over to which extent the current operational framework of mediation is effective. These concerns stem from the fact that the current framework fails to address the ethical challenges of the mediation process and they result from an approach focused on a strict set of rules. There is a discussion in literature that the well-established principles of neutrality and confidentiality which have long served as the core quality requirements eventually resulted in an outcome dominated by the more powerful party. Moreover, it has been argued that only a party-driven mediation process based on self-determination can lead to viable solutions and reinforce the confidence of the parties in both their competence and the interaction quality. Furthermore, it has been argued that the concept of self-determination can be achieved only if the parties actively and directly participate in the process and choose and control the norms to guide their decision-making; therefore, they feel that the agreement they reached was their own and not forced to accept or not accept a settlement which reflects a third party's norms, experience, or will.

The concept of self-determination is connected with the concept of autonomy, which is defined as a second-order capacity of a person to reflect critically upon their first-order preferences (say one is envious - first-order preference - and does not want to be envious - second-order preference) and the capacity to change these in light of higher-order preferences and values. Moreover, the concept of self-determination is related to fundamental values such as participation, dignity, respect, privacy, equity, and access. These values may be fundamental for the settlement process since settlement may be based on important non-legal principles or interests which may be more important to the parties than the legal considerations. These values of dignity, respect, etc. are the ones which highlight the importance of party involvement in the negotiation and decision-making components of mediation to the outcome's fairness.

## 4. The Proposed Platform

### 4.1. Smart contracts

Smart contracts are contracts written in code which run when the programmed conditions are met. Thus, the happening of the pre-specified events will trigger their execution. They are automated and unchangeable. They can be either drafted contracts or standard form contracts and in both cases they are easily and quickly adopted. The transparency of the system together with the automation benefits the parties since there is little space for different interpretations.

Since their design is different from traditional contracts several novel issues arise one of which is how the dispute will be resolved. Smart contracts as the traditional contracts may include a jurisdictional clause as well as define the method by which the dispute will be resolved. Thus, we could possibly follow an approach where we don't differentiate smart contracts from traditional contracts and apply the same alternative dispute procedure. One other approach might be to develop a new system to govern the enforcement of these contracts. In this work, the first approach will be considered where a specially designated smart contract clause determines an alternative dispute resolution system, specifically mediation.

### 4.2. Mediation platform characteristics

We believe that the already mentioned principles of mediation process should be incorporated on the Mediation platform. The self determination and the related moral values should be the core concept in the mediation process. An online Mediator can be a software tool monitoring the execution of e-contracts that can interfere when an alert is generated. An alert can be generated either automatically by the e-contracting system where the mediation process will be initiated by the system or the alert can be triggered by one of the parties. In addition, a human supervisor maybe be introduced to intervene when needed and ensure the system remains compliant with the designing principles. In such a case automated smart contracts are directly linked with the dispute resolution mechanism.

One of the main drivers for the parties to participate in an automated mediation platform is to meet their expectation for reducing their costs, reduce error possibilities, save time and achieve a direct and fast access to justice. Moreover, achieving a system design that can be conceived as transparent and fair, considering equally for the parties an increased trust in the service can be achieved. The introduction of the Mediator Platform that provides clear and accurate information about the scope, the benefits, the consent and withdrawal options as well as the limitations of the adoption of the system to the

parties in a simple and plain way is required.

In addition to the system design, the system should also address other legal issues such as a plan on how the data will be accessed and protected. Moreover, there should be mechanisms for system failure thus it is important the drafting of the relevant clause with specific attention to liability clauses. In cases the system for whatever reason needs to be terminated there will be an alternative system that can facilitate the discussion. Moreover at the end of the session and after an agreement has or has not been reached the system will evaluate itself and improve. The evaluation of the system will include whether the desired result has been achieved and ask and evaluate the parties experiences.

### 4.3. System architecture

#### 4.3.1. Overview

The design of a mediation platform should be based on human behavioural characteristics. The proposed platform encompasses the following modules that reflect the aforementioned characteristics.

#### 4.3.2. Blockchain e-contract creation module

The mediation process will be based on an online e-contract creation and execution system. In this system the legal contract is transformed to contract written in code and it is automatically executed. This module is similar to the one presented in detail in [29]. This module is enhanced with an alert system so that the parties or the system can initiate an alert that will trigger the workflow mediation process execution. All related evidence to the execution of a smart contract are available to the mediation process.

#### 4.3.3. Workflow module

It is the main part of the architecture as it is responsible for the visualization and execution of the mediation process. One of the main purposes of the workflow is to present in a clear way the steps of the process and gain trust that all the steps of the process will be followed since this is an automated system of execution. Figure 2 presents a generic outline of a workflow execution process.

#### 4.3.4. Behavioural matching module

This module will collect the profile of the parties. Each party when registering to the mediation platform they accept that when alerts occur the mediation process will be triggered and a similar clause is added to their e contract. Moreover, they provide some details regarding their profile. If accepted they also provide their accounts in social

media like Twitter. The behavioural and affective matching module, selects related information and extracts the emotional profile and the behavioural profile of the users. For example, how extrovert the users are, their homophily, their degree of influence in the network, etc. When two parties are in conflict their similarity is computed. The latter can be done with a number of metrics such as the cosine similarity.

#### 4.3.5. Data mining module

The data mining module searches for related cases. There are several algorithms that can be applied to retrieve a cluster of similar cases. In [39] k-NN is used to create clusters of similar legal cases.

#### 4.3.6. Mediator negotiation module

The mediator software is responsible for proposing a fair deal to both parties. Initially the mediator reveals successful solutions to similar cases based on the data mining module. If the parties agree to select one of these cases then the problem is solved and the accepted report is generated. If not then each agent of each party is entering the negotiation platform. Following for example an alternating offers protocol, the offers of both sites are sent to the mediator software that will return with a proposal that optimizes the differences of the two parties. The mediator module extends the traditional agent negotiation by introducing an entity that is aware of all related information. This entity also has the trust of both parties. Each party is represented by an agent that has a utility function that wants to maximize. An example negotiation system can be formed on BDI agents. Agents can be formed following the belief-desire-intention model. Each agent based on its beliefs it selects an appropriate action. Agents execute actions based on a set of rules. The mediator is a special agent responsible for the collaboration of the agents while parties are the agents that negotiate.

## 5. Conclusion

In this paper we discussed the behavioural aspects that need to be considered in order to establish effective dispute resolution principles in cases of conflicts related to smart contracts. The principal findings are the following: the existing principles of neutrality and impartiality has proven not to be effective and trustworthy. In contrast the principle of self determination and the related moral values of the parties should be the centre of the mediation process. The self-determination makes the parties to trust the procedure as well feel that this is their outcome and not somebody else. Therefore, we propose online mediation systems with AI design that considers these

parameters as the central role of the mediation. Additionally, other instruments can be supportive of this effort such as creating dispute resolution ethical/behavioural guidelines to clarify what the parties expect from the dispute resolution mechanism, Instruments of cooperation among smart contract parties: parties less cooperate if they think that their ethical and behavioural aspects will be ignored. In contrast, if they believe that all aspects will be considered the degree of cooperation will be improved as well as guidelines help guide mediators in making an overall assessment of the parties' discussions, these guidelines can be embedded in the software and also presented in the parties at the beginning of the process. In the future we plan to elaborate more in each of the module and select algorithms that lead to self-determination.

## References

- [1] N. M. Alexander, Mediation: The new normal? (2017). URL: <https://www.ssrn.com/abstract=3742561>. doi:10.2139/ssrn.3742561.
- [2] S. Wang, L. Ouyang, Y. Yuan, X. Ni, X. Han, F.-Y. Wang, Blockchain-enabled smart contracts: architecture, applications, and future trends, *IEEE Transactions on Systems, Man, and Cybernetics: Systems* 49 (2019) 2266–2277.
- [3] T. Hewa, M. Ylianttila, M. Liyanage, Survey on blockchain based smart contracts: Applications, opportunities and challenges, *Journal of Network and Computer Applications* 177 (2021) 102857.
- [4] L. W. Cong, Z. He, Blockchain disruption and smart contracts, *The Review of Financial Studies* 32 (2019) 1754–1797.
- [5] Y. Voutos, G. Drakopoulos, P. Mylonas, Smart agriculture: An open field for smart contracts, in: *SEEDA-CECNSM, IEEE, 2019*. doi:10.1109/SEEDA-CECNSM.2019.8908411.
- [6] A. Savelyev, Contract law 2.0: 'smart' contracts as the beginning of the end of classic contract law, *Information & Communications Technology Law* 26 (2017) 116–134.
- [7] K. Lauslahti, J. Mattila, T. Seppala, Smart contracts—how will blockchain technology affect contractual practices? (2017).
- [8] C. Menkel-Meadow, The evolving complexity of dispute resolution ethics, *Geo. J. Legal Ethics* 30 (2017) 389.
- [9] D. W. Allen, A. M. Lane, M. Poblet, The governance of blockchain dispute resolution, *Harv. Negot. L. Rev.* 25 (2019) 75.
- [10] A. Schmitz, C. Rule, Online dispute resolution for smart contracts, *J. Disp. Resol.* (2019) 103.
- [11] J. K. Martinez, Designing online dispute resolution, *J. Disp. Resol.* (2020) 135.

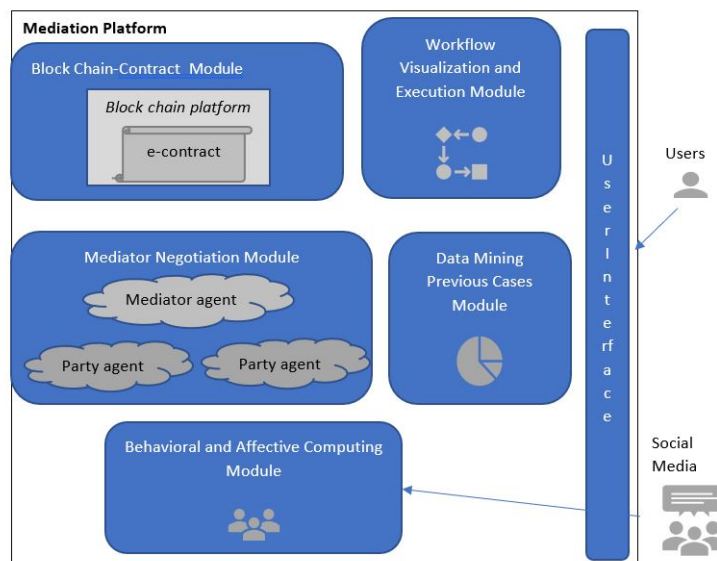


Figure 2: Mediation Platform

- [12] D. Q. Anderson, Ethical concerns in court-connected online dispute resolution, *IJODR* 5 (2018) 20.
- [13] M. Durovic, F. Lech, The enforceability of smart contracts, *Italian LJ* 5 (2019) 493.
- [14] N. Filatova, Smart contracts from the contract law perspective: Outlining new regulative strategies, *International Journal of Law and Information Technology* 28 (2020) 217–242.
- [15] O. Rabinovich-Einy, E. Katsh, Blockchain and the inevitability of disputes: The role for online dispute resolution, *J. Disp. Resol.* (2019) 47.
- [16] G. Drakopoulos, E. Kafeza, H. Al Katheeri, Proof systems in blockchains: A survey, in: *SEEDA-CECNSM*, IEEE, 2019. doi:10.1109/SEEDA-CECNSM.2019.8908397.
- [17] H. Watanabe, S. Fujimura, A. Nakadaira, Y. Miyazaki, A. Akutsu, J. Kishigami, Blockchain contract: Securing a blockchain applied to smart contracts, in: *ICCE*, IEEE, 2016, pp. 467–468.
- [18] S. Aggarwal, N. Kumar, Blockchain 2.0: Smart contracts, in: *Advances in Computers*, volume 121, Elsevier, 2021, pp. 301–322.
- [19] G. Governatori, F. Idelberger, Z. Milosevic, R. Riveret, G. Sartor, X. Xu, On legal contracts, imperative and declarative smart contracts, and blockchain systems, *Artificial Intelligence and Law* 26 (2018) 377–409.
- [20] J.-C. Cheng, N.-Y. Lee, C. Chi, Y.-H. Chen, Blockchain and smart contract for digital certificate, in: *ICASI*, IEEE, 2018, pp. 1046–1051.
- [21] K. N. Griggs, O. Ossipova, C. P. Kohlios, A. N. Baccharini, E. A. Howson, T. Hayajneh, Healthcare blockchain system using smart contracts for secure automated remote patient monitoring, *Journal of medical systems* 42 (2018) 1–7.
- [22] P. De Giovanni, Blockchain and smart contracts in supply chain management: A game theoretic model, *International Journal of Production Economics* 228 (2020).
- [23] G. A. Oliva, A. E. Hassan, Z. M. J. Jiang, An exploratory study of smart contracts in the Ethereum blockchain platform, *Empirical Software Engineering* 25 (2020) 1864–1904.
- [24] M. Alharby, A. Aldweesh, A. van Moorsel, Blockchain-based smart contracts: A systematic mapping study of academic research (2018), in: *ICCBB*, IEEE, 2018, pp. 1–6.
- [25] J. Liu, Z. Liu, A survey on security verification of blockchain smart contracts, *IEEE Access* 7 (2019) 77894–77904.
- [26] A. Singh, R. M. Parizi, Q. Zhang, K.-K. R. Choo, A. Dehghantanha, Blockchain smart contracts formalization: Approaches and challenges to address vulnerabilities, *Computers and security* 88 (2020).
- [27] A. Bhardwaj, S. B. H. Shah, A. Shankar, M. Alazab, M. Kumar, T. R. Gadekallu, Penetration testing framework for smart contract blockchain, *Peer-to-Peer Networking and Applications* 14 (2021) 2635–2650.

- [28] D. Macrinici, C. Cartofeanu, S. Gao, Smart contract applications within blockchain technology: A systematic mapping study, *Telematics and Informatics* 35 (2018) 2337–2354.
- [29] I. Kafeza, E. Kafeza, D. K. Chiu, Legal issues in agents for electronic contracting, in: *Proceedings of the 38th Annual Hawaii International Conference on System Sciences*, IEEE, 2005, pp. 134a–134a.
- [30] E. Kafeza, S. J. Ali, I. Kafeza, H. AlKatheeri, Legal smart contracts in Ethereum blockchain: Linking the dots, in: *2020 IEEE 36th International Conference on Data Engineering Workshops (ICDEW)*, 2020, pp. 18–25. doi:10.1109/ICDEW49219.2020.00-12.
- [31] G. Drakopoulos, E. Kafeza, P. Mylonas, H. AlKatheeri, Building trusted startup teams from LinkedIn attributes: A higher order probabilistic analysis, in: *ICTAI*, IEEE, 2020, pp. 867–874.
- [32] T. van der Linden, Trust Me: Combining online dispute resolution, law and blockchain technology, *Indian JL & Tech.* 15 (2019) 454.
- [33] D. Calvaresi, A. Dubovitskaya, D. Retaggi, A. F. Dragoni, M. I. Schumacher, Trusted registration, negotiation, and service evaluation in multi-agent systems throughout the blockchain technology, *2018 IEEE/WIC/ACM International Conference on Web Intelligence (WI)* (2018) 56–63.
- [34] R. Koulu, Blockchains and online dispute resolution: Smart contracts as an alternative to enforcement, *SCRIPTed* 13 (2016) 40.
- [35] S. A. McKinney, R. Landy, R. Wilka, Smart contracts, blockchain, and the next frontier of transactional law, *Wash. JL Tech. & Arts* 13 (2017) 313.
- [36] J. R. Sternlight, Pouring a little psychological cold water on online dispute resolution, *J. Disp. Resol.* (2020) 1.
- [37] U. Jeretina, Consumer online dispute resolution (ODR)-a mechanism for innovative e-governance in EU, *Cent. Eur. Pub. Admin. Rev.* 16 (2018) 45.
- [38] W. A. Kaal, C. Calcaterra, Crypto transaction dispute resolution, *The Business Lawyer* 73 (2017) 109–152.
- [39] M. Lefoane, T. Koboyatshwene, L. Narasimhan, kNN clustering approach to legal precedence retrieval, in: *Twelfth International Workshop on Juris-Informatics (JURISIN 2018)*, 2018.