Expanding the Platform: Smart Contracts as Boundary Resources

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Abstract Platform businesses are born global, with instant access to global markets. Thanks to the algorithmic, self-executing and self-enforcing computer programmes known as smart contracts, platform businesses now also have instant access to global capital markets from birth. However, the legal status of these smart-contract-enabled funding mechanisms and smart contracts in general is not well defined. In this article, we analyse how well the formation mechanisms of the general principles of Finnish contract law can be applied to the technological framework of smart contracts. We find that depending on the case, smart contracts can create legally binding rights and obligations to their parties. We also observe that contracts have not been formerly perceived as technical boundary resources in the sense that platform ecosystems could foster broader network effects by opening their application contracting interfaces to third parties.

Keywords Platform · Smart contract · Boundary resource · Contract law · ICO

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From Digital Contracts to Lex Cryptographia

In 1994, American cryptographer Nick Szabo published an article in which he outlined the concept of smart contracts.[1] Szabo defined smart contracts as machine-readable transaction protocols which create a contract with predetermined terms.[2] In its simplest form, a smart contract is a machine-readable programme, written in code that will execute itself when a set of predetermined terms are met.[3]

Regardless of the advanced ideas and the advanced concept, the IT infrastructures of the era were considerably behind the level required to bring Szabo's vision to reality, and the time was not yet ripe for practical experimentation.[4] Now years later, the concept of smart contracts has resurfaced as the technological development has caught up with the vision.[5] New technical advances in blockchain technology[6] have enabled the transition from automated digital contracts to truly autonomous smart contracts, capable of self-execution and self-enforcement.

The relationship between platforms,[7] blockchain-based smart contracts and contract law creates an interesting research environment in which the traditional definition of contracts is placed under review as coded programmes begin to administer transactions. Moreover, legal research on blockchain technology has been said to lead to the development of a new legal field which can be described as *Lex Cryptographia*, or crypto law.[8] Determining the legal nature of smart contracts is in

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[1] The original text *Smart Contracts* is available at http://szabo.best.vwh.net/smart.contracts.html (17 June 2016). The text *The Idea of Smart Contracts* published in 1997 took the idea of smart contracts further: http://szabo.best.vwh.net/smart_ contracts_idea.html (17 June 2016).

[2] By transaction protocols Szabo meant protocols between different devices, which achieve the so-called Nakamoto consensus. Szabo 1994: "A smart contract is a computerised transaction protocol that executes the terms of a contract". According to a newer definition, a smart contract is "a set of promises, specified in digital form, including protocols within which the parties perform on these promises" Szabo 1996.

[3] It is noteworthy that smart contracts do not need artificial intelligence to work, regardless of what their name may suggest.

[4] See, e.g. Glatz 2014: *What are Smart Contracts? In search of a consensus.*

[5] For example, http://tech.cornell.edu/news/smart-contracts-the-next-big-blockchain-application (23 August 2016)

[6] For this chapter, we define blockchain technology as the cryptographically concatenated data structure and the network architecture described by Nakamoto (2008) which entails a proof-of-work consensus protocol and employs cryptographic tokens of value, more commonly referred to as cryptocurrency.

[7] For this chapter, we define a platform as an IT system that enables a multisided market environment where different market sides can perform value-adding activities that are complementary to one another and which are governed by boundary resources. For further platform literature, see, e.g. Cusumano and Yoffie 1998; Cusumano and Gawer 2002, Cusumano 2005, 2010; Parker and Van Alstyne 2005; Eisenmann et al. 2006; Gawer and Henderson 2007; Boudreau and Hagiu 2008; Gawer and Cusumano 2008; Gawer 2009; Baldwin and Woodard 2009; Tiwana et al. 2010; Yoo et al. 2010; Kenney and Pon 2011; Parker and Van Alstyne 2014; Hagiu 2014; Pon et al. 2014, 2015 Parker et al. 2016.

[8] A new legal field *Lex Cryptographia* focuses on rules which are managed through self-executing smart contracts and decentralised autonomous organisations. See Wright and De Filippi 2015, p. 48.

fact a key theme in the surrounding discussion[9] in which they have been increasingly assessed as legally relevant activity.[10] Thus, it should be noted that smart contracts are not only administered by their programming logic or, in other words, the code they contain; they are also inseparably influenced by the state of the law.[11]

Platform businesses are born global, with instant access to global markets. Through recent developments in smart contracts, platform businesses now also have instant access to global capital markets from birth.[12] However, the legal status of these smart-contract-enabled funding rounds and smart contracts in general is not well defined at this point. The techno-economic point of view has traditionally been selected as the dominant way for understanding technological disruptions and their effects. In recent years, however, legal regulation has also been increasingly understood as an equally important factor in developing innovations in the platform economy.[13] This calls for a systematic review of the legal doctrinal composition of smart contracts within the context of an established legal framework.

Frameworks of the same historic background – such as those with their roots in the Romano-Germanic legal tradition – share more commonalities with each other than with systems descending from another historic background, such as those based on the common law legal tradition. Therefore, there are differences in the compositions of contractual mechanisms in different legal frameworks. Thus, an all-pervasive systematic review cannot be covered in one research article. Instead, the legal doctrinal composition of smart contracts must be evaluated for each legal framework individually.[14]

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[9] About the nature of smart contracts more generally: "They are defined variously as 'autonomous machines', 'contracts between parties stored on a blockchain' or 'any computation that takes place on a blockchain'". Many debates about the nature of smart contracts are really just contests between competing terminology […]", http://www.coindesk.com/making-sense-smart-contracts/ (23 August 2016).

[10] Glatz 2014: "It is however undeniable, that smart contracts have to be classified as legally relevant behavior. […]". See also Koulu 2016, p. 54.

[11] See, e.g. *Blockchain 2.0, smart contracts and challenges*: http://www.twobirds.com/en/news/articles/2016/uk/blockchain-2-0--smart-contracts-and-challenges#1 (23 August 2016).

[12] Global capital markets have been enabled by a phenomenon around blockchain technology generally referred to as *token sales* or *initial coin offerings (ICO)*. For more information on ICOs, see, e.g. Conley 2017.

[13] See Chander 2014.

[14] It is noteworthy that the legislation concerning electronic contracts and information society in general has been harmonised to an extent on the EU level (e.g. in Finland's case, see the Finnish Information Society Code, 917/2014). In the case of characterising the legal status of a single service provider utilising smart contracts, a more systematic review on the EU level could be in order. However, as this chapter focuses on answering a more basic question about the contractual applicability of smart contracts in general, this harmonised legislation does not fall within the scope of this research. Similarly, on the national level, other mandatory provisions (e.g. distance selling and distance selling of financial services) may have legal implications concerning smart contracts. These include inter alia, the conclusion of special consumer contracts and other public-law-oriented provisions in acts such as the Money Collection Act (255/2006), the Crowdfunding Act (734/2016) and the Securities Markets Act (746/2012).

In this chapter, we examine the relationship between blockchain-based smart contracts and Finnish contract law.[15] The main research question herein is *whether or not legal acts can be concluded with smart contracts under Finnish contract law*.[16] In order to provide an answer, it must, first of all, be clarified how the general doctrines of contract law are applicable to these new smart contracts in terms of conferring rights and imposing obligations on parties. Secondly, it must be determined whether all smart contracts constitute contracts in themselves, or whether there are internal requirements for their legal significance.[17]

We conclude the chapter with a discussion on the implications of our findings on multisided platforms and the platform economy at large. Smart contracts are a clear example of how some social boundary resources of platforms are developing in an increasingly technical direction and should be perceived as technical enablers, similarly to technical boundary resources.[18] Contracts in themselves have not been formerly perceived this way, in the sense that the network effects of a platform ecosystem could be boosted by opening up "application contracting interfaces". This would mean, for instance, the application of even further automated digital contracting mechanisms, process automation that reaches further beyond a company's own information systems, as well as further automated and more dynamic networks of contracting parties.

This chapter continues as follows: In the second section of the chapter, we will outline the definition of smart contracts and discuss the creation of a smart contract from the perspective of contract law. In section three, we will seek to answer the

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[15] Due to the notable proximity of the Finnish legal framework to those of the other Nordic countries, some analogies thereto most likely are justified.

[16] In this chapter, the research method of choice is mainly legal doctrinal (or legal-dogmatic) research, the main focus being on the research of current positive law – but in our case, examined in a broader context of the platform economy. See Hirvonen 2011, pp. 21–23 and 28–30.

[17] In this publication, it is not possible to discuss central guidelines not related to the content of smart contracts or the interpretation of such content. Questions regarding parties and legal entities in general have also been left undiscussed apart from a few mentions. Furthermore, the question of which country's national legislation should be applied to smart contracts is also interesting. Smart contracts exist in a blockchain that functions in a decentralised environment, and the parties (of which there may be several) may be completely unknown to one another. Therefore, it may not be clear which jurisdictions are relevant to the contract unless specifically referred to in its terms. It is important to study this question, but it is likely that any factual solutions to this issue will only be found through practice. In addition to the questions above, it is also important to consider how programming is viewed by Finnish contract law. Is it possible to equate the programming of a smart contract to a middleman, comparable to counsel drafting a traditional contract? While these interesting questions are mostly brushed aside in this text, it should be noted that the importance and role of programming will be an increasingly important topic in the future.

[18] In platform literature, boundary resources are the operational regulations and technical tools and interfaces governing the interaction between the platform owner and the platform participants. They can be used either to encourage platform development or to restrict it in places where the platform owner wishes to maintain control over the developmental direction of the platform. These resources are sometimes divided into technical and social boundary resources. For further information, see, e.g. Gawer 2009; Yoo et al. 2010; Ghazawneh 2012; Ghazawneh and Henfridsson 2013.

question of whether legal acts can be concluded with smart contracts, and finally, in section four, we will discuss the impact of smart contracts in the context of development trends of digital platforms and the surrounding ecosystems.

The Nature of Smart Contracts

Smart Contracts

A fully established definition for smart contracts has yet to be formed. According to Nick Szabo, creator of the concept behind smart contracts, however, the most primitive example of a smart contract is, in fact, a regular vending machine where transactions are based on simple mechanical automation. The vending machine, due to its physical design, accepts coins, hands over the selected item and finally returns the change. The machine, therefore, completes the transaction on its own when the necessary prerequisites are met – that is, a sufficient amount of money has been deposited into its slot. Anyone in possession of a sufficient amount of coins and with the desire to purchase one of the items for sale is capable of becoming a contracting party in this type of a transaction. Additionally, since the items for sale are situated within the vending machine, it is capable of protecting the logic of its proposed contract from unauthorised changes.[19]

Much in the same way as vending machines, digital smart contracts can essentially be characterised as cryptographic "boxes" containing value that only unlocks upon the fulfilment of the preconditions determined in their design.[20] In other words, smart contracts are automated mechanisms under the control of which assets can be deposited and which then autonomously redistribute those assets according to their internal programming logic.[21] As such, smart contracts enable the execution of transactions to be automatically based on data that was not yet available when the contract itself was concluded.[22]

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[19] Szabo 1994.

[20] Ethereum White Paper 2013.

[21] From a more technical point of view, smart contracts are autonomous programmes situated in a certain address in the blockchain, which can be rerun infinitely and can also be programmed to contain a wide array of business model logics. Once the events specified in the contract take place and the transaction containing data arrives to the address of the smart contract, the distributed virtual machine of the blockchain executes the programming code of the smart contract in question. Ethereum is one example of this type of a blockchain platform with an integrated virtual machine layer which allows programmes to be run in a fully decentralised fashion and thus can facilitate smart contracts. See, e.g. http://ethdocs.org/en/latest/introduction/what-is-ethereum.html (23 August 2016). BBVA Research – Digital Economy Outlook, October 2015, p. 4 (https://www.bbvaresearch.com/wp-content/uploads/2015/10/Digi-tal_Economy_Outlook_Oct15_Cap1.pdf) (23 August 2016).

[22] Buterin 2014.

Diverging from contracts concluded in the form of action, speech or writing, a smart contract is characteristically a computer programme built in code. Moreover, as currently employed in reality, smart contracts are based on decentralised peer-to-peer networks and reside in a distributed network database known as a blockchain.[23] In order to implement a contractual arrangement as a smart contract in practice, the terms of the proposed contract are formulated in programming language, after which the smart contract is deployed in the blockchain. Once deployed, the distributed blockchain network executes the smart contract automatically without the assistance of the contracting parties whenever the conditions outlined in the code of the smart contract are met.

Due to their decentralised nature, smart contracts are often said to be *self-executing* and *self-enforcing*. In other words, they differ significantly from conventional forms of digital contracts, such as clickwrap contracts, in that they do not require a centralised trusted party to administer the execution of the contract in the digital world.[24] Moreover, blockchain networks are capable of preventing unauthorised changes to the internal logic of the smart contracts in their distributed database. Therefore, no party or authority has the power to prevent such networks from executing the smart contracts in their original form.[25]

Based on all the characterisations above, we define smart contracts for this chapter as digital programmes that

(a) Are written in computer code and formulated using programming languages
(b) Are stored, executed and enforced by a distributed blockchain network
(c) Can receive, store and transfer digital assets of value
(d) Can execute with varying outcomes according to their specified internal logic

From this definition, it is easy to see that the established term for describing such cryptographic boxes of value, namely, "smart contracts", can be quite misleading, as their smartness as well as their contractual nature can both be called into question. In essence, smart contracts are merely automatic programmes built in code and deployed on a blockchain to perform logical processes. Thus, the term "smart contracts" is also commonly used in connection with many other types of programmes situated in the blockchain and not only those resembling a formal agreement.[26] Smart contracts are also capable of actions such as collecting data from outside resources (API oracles) and processing it according to the terms specified in their

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[23] At the moment, the most prominent of such platforms for smart contracts is a blockchain known as Ethereum (see https://www.ethereum.org/ (23 August 2016). For additional information on blockchain technology in general, see, e.g. Mattila (2016).

[24] For more information on the role of smart contracts in the evolution of digital contracts in general, see, e.g. (Werbach and Cornell 2017; Kõlvart et al. 2016).

[25] Mattila 2016, p. 15. The irreversibility of some contracts may prove to be a problem in some situations. This issue will, however, not be discussed further in this text.

[26] See, e.g. Stark, Josh: *How Close Are Smart Contracts to Impacting Real-World Law?* http://www.coindesk.com/blockchain-smarts-contracts-real-world-law/ (23 August 2016).

programming logic and executing concrete varying outcomes based on the results of this procedure.[27]

Nonetheless, it is possible to give smart contracts characteristics that can be likened to those of conventional contracts – at least from a theoretical viewpoint – by formulating their internal logic accordingly.[28] In such cases, smart contracts begin to show contract-like characteristics once digital assets have been transferred to their control and once they are transferred again in order to redistribute them according to the prespecified criteria.[29]

Contract Law and the Interpretation of Smart Contracts

Contracts are a key legal instrument for private operators as they execute changes in their legal relations or try to prepare for future turns of events. Contracts also enable organised collaborative activity and are often used to carry out economic activity.[30] The definition of the term "contract" contains a number of different meanings. First of all, the term may refer to the conclusion of the agreement itself, therefore describing the parties' commitment to the contract. Secondly, it may refer to the contents of the agreement, therefore determining the parties' rights and obligations in relation to one another. Thirdly, it may refer to the actual document in which the terms of the contract have been specified.[31]

Contract law is traditionally non-mandatory. In other words the parties can disregard certain rules of presumption by implementing their own terms. This principle of freedom of contract is the premise from which Finnish contract law also sets out. For a number of reasons, however, freedom of contract is restricted by certain mandatory rules regarding the content of agreements.[32] The main principle is, nonetheless, that parties can exercise full freedom in deciding whether to enter into a contract, with whom, in what manner and with what terms. The right to decide on

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[27] BBVA Research – Digital Economy Outlook October 2015, p. 4 (https://www.bbvaresearch.com/wp-content/uploads/2015/10/Digital_Economy_Outlook_Oct15_Cap1.pdf) (23 August 2016)

[28] Koulu 2016, p. 65: "[…] the smart contract operates with a similar logic to 'traditional' contracts: the will of both parties to enter the agreement is needed in order for it to be valid".

[29] It must be noted, however, that the aforementioned course of events is only a presumption, and the smart contract can also remain at a stage where it functions purely as a re-router built to transfer data or, for instance, the contents of one crypto-wallet to another (Bourque and Fung Ling Tsui 2014, p. 10). The legal status of such smart contracts can indeed be questioned with good reason, at least from the perspective of contract law. Therefore, their interpretation would seem to require case-by-case evaluation.

[30] Hemmo 2003, p. 4; 2006, p. 27.

[31] Saarnilehto et al. 2012, p. 310.

[32] Hemmo 2003, p. 77.

the dissolution of a contract has also been considered an important, yet separate, part of freedom of contract.[33]

In addition to the principle of freedom of contract, the Finnish legal system also acknowledges the principle of *pacta sunt servanda*, that is, agreements must be kept.[34] Various sanction mechanisms also make it necessary to abide by the contracts one has entered into, since the other party has the opportunity to claim damages or enforce the contract by the help of the authorities.[35]

In this publication, we will address contracts as individual agreements concluded between rational and equal private parties with the main purpose of organising economic legal relations. Due to practical reasons, our presentation of Finnish contract law will be limited to a rather general level, focusing on the mechanisms leading to the conclusion of a contract. Our goal in this endeavour is to analyse through doctrinal research[36] and as straightforwardly as possible those aspects of contract law which are relevant to the interpretation of smart contracts. This perspective leaves out several significant legal themes which we are not able to explore in this publication. Since there has been little research on smart contracts, this type of approach is necessary in order to define them and assess them in a legal context.

Legal Acts, Declarations of Intent and Contracts

The relationship between legal acts and contracts has so far been widely discussed in Finnish legal literature, and scholars have tried to find differences in the meanings of these terms. Recently, however, these terms have increasingly often been used as synonyms for each other,[37] although Finnish legislation still includes well-established expressions which utilise the term legal acts. In this publication, we will adhere to the practice of using the two terms synonymously.

Consent, declaration of intent and the purpose that this intent becomes known to the other party have all been considered sine qua non for a legal act. Consent refers to a party's free will to become bound by the contract. In addition, this consent must become known to the recipient in one way or another.[38] Declaration of intent refers

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[33] Hemmo 2003, pp. 69, 72 and 75–77.

[34] Section 1(1) of the Finnish Contracts Act (228/1929): "An offer to conclude a contract and the acceptance of such an offer shall bind the offeror and the acceptor as provided for below in this chapter".

[35] Hemmo 2003, p. 14; Saarnilehto 2009, pp. 161–163.

[36] Doctrinal research, or legal dogmatics, attempts to study law as it currently stands. See more: Hirvonen 2011, pp. 21–26.

[37] For example, Mika Hemmo has used these two terms as synonyms. For more, see Hemmo 2003, pp. 10–11 and Hemmo 2006, p. 26.

[38] Saarnilehto et al. 2012, p. 323.

to the expression of a party's[39] free will as a prerequisite to the conclusion of a contract. Both parties are free to decide what their will is and how they are bound to the decision. Although the declaration of intent should by principle be directly addressed to a certain other person or group, even a declaration of intent addressed to a more vaguely specified person or group of people can be seen as valid.[40] This, however, requires a restriction of some sort regarding the targeted group, as entirely unspecified public declarations of intent have by principle been considered non-binding. The reasonable impression that the declaration has had on the recipient has been utilised as a key argument in assessing whether or not the declaration has binding effects. For instance, an advertisement in a newspaper has not as such been considered a sufficient offer.[41] On the other hand, an automat which has been set up with its for sale items and relevant information (regarding prices, methods of payment, products, etc.) may be considered a de facto offer which has been made to a sufficiently limited audience, that is, those in the immediate vicinity of the automat.

The declaration of intent must be expressed clearly. That said, an implied expression of intent is also valid, and intent can be expressed through various forms of communication. The thought or idea of an agreement alone, however, does not constitute a declaration of intent. The method, form and audience of the declaration are not subject to overly strict regulation, and it is in fact sufficient that consent is expressed in one way or another.[42] It is also not imperative to apply an overly strong presumption on the necessity of such a declaration. Not all methods of concluding a contract even require a proper declaration of intent. Additionally, the declaration of intent does not need to be entirely separate from the agreement, as a contract can also be concluded based on passivity or concrete actions.[43] It follows that a party's true will to be bound and some expression of this intent are of key importance.

A contract is a bilateral legal act which establishes rights and obligations for the parties to it. Only the parties to a contract may demand that these obligations should be met. A third party only has this right in certain exceptions.[44] In Finnish jurisprudence, contracts have traditionally been defined as the combination or amalgamation of two or more legal acts requiring one another. In some cases, specific requirements as to form must also be met, or certain actions must be performed before a contract can fully enter into force.[45] The conclusion of a contract is often

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[39] In Finland, "legal acts" can be concluded by all natural persons (i.e. humans) and legal persons for whom requirements have been set in order to have legal capacity. Questions about legal entities may arise especially in relation to decentralised autonomous organisations but also about the different interpretations relating to the nature of smart contracts. Some researchers have considered smart contracts as agents based on algorithmic contracts acting for and on behalf of their principal or even independent legal entities. See, e.g. Scholz, Lauren Henry: Algorithmic Contracts (draft, 2016) and Bourque and Fung Ling Tsui 2014, pp. 18–19. Questions about legal entities have their own connection to smart contracts, but that will not be considered any further in this text.

[40] Saarnilehto et al. 2012, p. 323.

[41] Hemmo 2006, pp. 78–79.

[42] Saarnilehto et al. 2012, p. 328.

[43] Hemmo 2003, pp. 11–13.

[44] Norros 2007, pp. 1–3

[45] Saarnilehto 2009, p. 3; Saarnilehto et al. 2012, pp. 367–368.

related to the organisation of economic activity.[46] In recent decades, however, the social dimension of contracts has also been emphasised. A reasonable balance in terms of the material content of a contract has been considered a prerequisite for the binding effect of a contract. In addition, parties in a weaker position are not thought to have a very extensive duty to investigate or make enquiries.[47]

Mechanisms for Concluding Contracts

The so-called offer–acceptance mechanism, as it is regulated in the Finnish Contracts Act, is seen as the traditional method for concluding a contract and is based on two legal acts. As contracts are becoming all the more diverse, the offer–acceptance mechanism is not, however, always the most accurate description of the process leading to the conclusion of a contract.[48] Under section 1 of the Contracts Act, the offer to conclude a contract and the acceptance of such an offer are binding in regard to the offeror and the acceptor. The Contracts Act, however, does not apply to contracts of standard form or contracts which require acting upon in order to become effective.[49] The response to the offer must be delivered on time and must accept the original offer as such. The Contracts Act provides that a response that purports to be an acceptance, but includes additions or restrictions, is to be deemed a rejection constituting a new offer directed at the original offeror.[50]

Mechanisms for concluding a contract not regulated by the Contracts Act include contracts concluded through negotiation, implied contracts and tacit agreements. Standard-form contracts are also considered to be formed outside the offer–acceptance mechanism.[51] Aside from contracts concluded via the offer–acceptance mechanism, implied contracts and tacit agreements are the most relevant to smart

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[46] This characteristic has at least been heavily emphasised. See Hemmo 2006, p. 24.

[47] See, e.g. Hemmo 2003, pp. 19–24. The so-called social civil justice emphasises the mutual trust between the parties and the principle of equity of contracts. An unreasonable contract or individual term may, therefore, be amended by the court for reasons of equity. This feature of Finnish contract law will most likely be applied to smart contracts as well. Only time will tell, however, whether courts will have the competence to evaluate whether a smart contract written in computer code is equitable.

[48] Hemmo 2003, pp. 96–97.

[49] These kinds of contracts, which require acting upon (the interposition of something), are called real contracts and, in legal literature, have been considered to have very little importance in Finland. "*Reaalisopimuksen sitovuuden edellytyksenä on sopimuksen kohteen luovuttaminen toisen hallintaan*" [For a real contract to be binding the subject matter of the contract must be handed over to the other party's possession]. See Hemmo 2003, pp. 100 and 180–181.

[50] Finnish Contracts Act (228/1929, as amended): http://www.finlex.fi/fi/laki/ajantasa/1929/19290228#L3 (23 August 2016). The Contracts Act includes more detailed provisions about responses given on time, power of attorney and invalidity of juristic acts.

[51] Hemmo 2003, pp. 129–137.

contracts. In addition, smart contracts may contain similar characteristics to contracts requiring acting upon in order to become effective.

Implied contracts refer to a situation where a contract is seen to have been concluded without explicit expressions of intent but rather based on social norms. In these situations a contract has been concluded based on some action, without any oral or written exchanges. Typically these actions have similar qualities to a contract and are part of a prevalent social convention which both parties are deliberately participating in.[52] Examples offered by legal literature of such social conventions could be using public transportation or parking in a paid parking lot. Using an automat has also sometimes been placed in this category. In summary, implied contracts are contracts based on certain facts inducing a contractual relationship but where no explicit offer–acceptance mechanism takes place.

The term "tacit agreements" is also used to describe a slightly similar phenomenon. The term refers to the conclusion of a contract through a situation in which no explicit declaration of intent can be detected, although the parties collaborate in a way that indicates the existence of a contractual relationship.[53] It has been stated in legal literature that it is mostly a matter of taste which term to use.[54,55] When parties collaborate in a way that denotes a contractual relationship, a contract is seen to have been implicitly concluded, even though the method and time of conclusion and the contract itself cannot be shown. Therefore, if parties have commenced action as if the contract were in force, despite the contract's itself remaining in the stage of negotiations or not yet having being concluded, an implicit contract may be in force between the parties. The interpretation of whether a tacit agreement has been concluded is based on overall evaluation, in which circumstances strongly speaking in favour of the existence of a contract can prove that a tacit agreement has entered into force. However, even rather minor arguments against the existence of a contract can relatively quickly lead to the conclusion that no tacit agreement has been reached between the parties.[56] Interpretation should not be too liberal in order to avoid parties being bound to contracts they have not declared their intent for.[57]

According to legal literature, a declaration of intent leading to the conclusion of a contract can be expressed by the parties through the exchange of assets or services with one another. A similar transaction-based interpretation has also been outlined in regard to smart contracts.[58] A declaration of intent by acting upon it can, for instance, take place in the purchase of items from a vending machine. In this case, the proprietor selling items and services via the vending machine has implicitly displayed its desire to conclude a contract with the terms specified by the vending machine. This is supported, for example, by the fact that the proprietor has first had

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[52] Hemmo 2003, pp. 131–133.

[53] Hemmo 2006, p. 88.

[54] Implied contract or tacit agreement.

[55] Saarnilehto et al. 2012, p. 385.

[56] Hemmo 2003, pp. 133–136.

[57] Hemmo 2006, p. 88.

[58] Koulu 2016, p. 65.

to obtain the vending machine and a location for it, set up the vending machine and fill it with products, programme the vending machine and make it operational before any contracts can be concluded. The user also expresses their will to be bound to the transaction similarly via the vending machine. The vending machine example can also be described using the offer–acceptance mechanism; however, tacit agreements seem more relatable to the reality of the phenomenon.[59]

The Supreme Court of Finland has stated in case KKO 2010:23 regarding private parking enforcement that the offer–acceptance mechanism of the Contracts Act no longer corresponds with all situations related to the conclusion of a contract. Contracts concluded via automats were mentioned in the ruling as another relevant example of these types of contracts.[60] The conclusion of a contract can therefore also be attributed to external characteristics presented in the parties' actions.[61]

Conclusion of a Smart Contract

In the previous section, we presented a number of mechanisms for concluding a contract. In this section, we will be comparing these mechanisms and evaluating how well contract law doctrines regarding the conclusion of contracts are applicable to smart contracts.[62]

Especially in the offer–acceptance mechanism of the Contracts Act, the parties' declarations of intent are explicit; in other words the acceptor is given the details of the offer and the offeror is given information on the response. On the other hand, as explained previously, consent can be expressed implicitly, for instance, through co-operation with the other party or the performance of duties. Since the doctrine on declaration of intent holds a strong principal position in the Finnish legal system, this must also be taken into account when discussing the conclusion of a contract from the perspective of smart contracts.

In reference to what has been discussed previously, it appears possible that smart contracts can be concluded based on the parties' declaration of intent. Although it

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[59] Saarnilehto et al. 2012, pp. 384–385.

[60] KKO 2010:23: "*Esimerkkeinä sopimuksista, joiden syntymisen edellytysten tarkasteluun oikeustoimilain periaatteet tuntuvat riittämättömiltä, on usein mainittu muun muassa erilaisia teknisiä välineitä, kuten automaatteja hyväksi käyttäen tehdyt sopimukset sekä sellaiset sopimuk-set, joita tehdään päivittäin ja toistuvasti suuria määriä ja jotka keskeiseltä sisällöltään ovat aina samanlaisia […]*". [As examples of contracts, the conclusion of which the principles of the Contracts Act seem insufficient to explain, two similar contract types can be mentioned: contracts concluded using various technical devices, such as automats, and contracts concluded again and again in large quantities which are essentially always the same by content.]

[61] Saarnilehto et al. 2012, pp. 384–385.

[62] This may also be interesting in order to evaluate the effects on third parties, i.e. *ultra partes*. Even though the matter will not be discussed further in this text, it contains very important follow-up questions outside of contract law, e.g. in relation to tort liability, consumer protection, jurisdiction, conflicts of laws as well as dispute resolution.

seems that the offer–acceptance mechanism can be applied to smart contracts, their conclusion seems to be better explained by the processes leading to tacit agreements and implied contracts. In the context of the offer–acceptance mechanism, the parties would come to a binding agreement via the offer of one party and the acceptance of the other. Only thereafter are transactions or other actions performed in accordance with the contract. With smart contracts, the intent of the party responsible for placing the smart contract in the blockchain seems to manifest in the same context where a contracting party transfers a certain digital asset to be managed by the smart contract.[63] Declaration of intent does not therefore appear to occur separately from the conclusion or execution of a smart contract but is rather an immovable part of the contract itself.[64] Then again, if observed in light of the offer–acceptance mechanism, a public smart contract added to the blockchain to which the party has transferred assets for management may perhaps be interpreted as an offer.[65] Respectively, another party's joining the smart contract may be seen as acceptance of the offer.[66]

The expressions of intent in the conclusion of a smart contract share many characteristics with a tacit agreement, where the contract is concluded by parties exchanging assets. When a party transfers the sum into the smart contract, and the other party begins to act based on the smart contract, the expressions of intent of both parties are included in the actions taken. Even though no deliberate expressions of intent are given, the actions of the other party are required in order to be bound to the contract.[67] A parallel can be drawn between this situation and the previously mentioned situation involving an automat. This interpretation is enforced partly by the fact that Szabo has mentioned in some of the first publications about smart contracts that an automat is the simplest form of a smart contract.[68]

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[63] This manner of concluding a contract includes some similarities to the aforementioned real contracts. While real contracts often require the subject matter of the contract to be lodged in the custody of the other party, it would have to be separately evaluated to what extent the transferred sum controlled by a smart contract could constitute such a subject matter.

[64] Koulu 2016, p. 65: "*The declaration of intent is not separate from the formation of the contract or from the execution of it*".

[65] It is a question of its own whether this type of offer and its acceptance are precise enough to meet the requirements of the offer–acceptance mechanism. When an announcement alone that a party is willing to conclude contracts does not necessarily constitute an offer (but rather an invitation to make one), the smart contract in the blockchain might not be such a specific offer either. See, e.g. Saarnilehto 2009, pp. 42–43.

[66] What may become interesting is the type of situation in which a complex smart contract has a wide range of unspecified creators, where it may be impossible to identify the offering party. A compelling question here is for instance how a group like this can validly act as an offeror. This theme will not, however, be discussed any more widely in this article.

[67] A different interpretation could be formed in a situation where it would be possible to commit to a smart contract by mistake or without understanding its true code-form content. These types of situations may be possible as the use of smart contracts becomes more popular, and it will be important to observe these situations in the future.

[68] Despite previous evaluations, a smart contract is not, for example, a mechanical automat containing beverages, but rather a programme which performs a specified action based on its programmed execution logic. A nearly infinite amount of different kinds of smart contracts can be programmed,

Based on aforementioned details, acts performed by the parties of a smart contract can likely be thought to fulfil the definition of declaration of intent.[69] Therefore, at least certain types of smart contracts can feasibly be concluded either by acting upon them or implicitly, as demonstrated in the aforementioned vending machine example. Here the "creator" of the smart contract announces their will to conclude contracts by building a smart contract in the blockchain and transferring, for example, certain assets to it. The other party of the smart contract expresses their will to be bound by performing an act in accordance with the terms of the contract, therefore accepting the offer without a distinct and explicit declaration of intent. Finally, when the preconditions specified in the smart contract are met, it executes itself automatically and, for example, redistributes the digital assets placed under its management or performs other tasks it has been appointed with, following which the contract can be thought to have been expired.[70]

However, not all smart contracts are as simple in reality. Next, we will discuss examples of different types of smart contracts and aim to highlight their various characteristics.

Can Smart Contracts Be Used to Perform Legal Acts?

Case: API Oracle

The first example is about so-called oracles, in other words routers connecting a set of application programming interfaces (APIs). This type of smart contract collects data from one or more third-party software interfaces or other sources and relays the collected information into the blockchain.

The main purpose of oracles is to provide information to other smart contracts in order to monitor the fulfilment of the terms of the contract. This is to ensure that one of the basic requirements of a functional consensus architecture is met: each party must be able to check the validity of the information in the blockchain. If the smart contracts were to monitor the fulfilment of the terms of the contract via information available on typical websites or third-party software interfaces, then the risk would be that each party would find different results, thereby undermining the reliability of the contracts. Hence all factors which will affect the smart contracts must be brought into the blockchain through oracles.

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so it is quite probable that not all smart contracts can be seen to involve the type of (at least implied) declaration of intent that is required to conclude a legally relevant act.

[69] In this chapter we have discussed smart contracts in accordance with the definitions described previously in this publication. In addition, it has been considered that a smart contract only has one creator and is joined by only one other party.

[70] The true intelligence of smart contracts can be questioned, as they do not contain artificial intelligence in themselves, as has been stated previously in this publication. A smart contract should thus be perceived as an automated mechanism which performs its defined functions as certain preconditions are met. The established term "smart contracts" is thus somewhat deceiving.

Quite understandably, there are some trust issues related to using individual oracles, where one wants to maintain the benefits of using decentralised consensus architecture. In its simplest form, however, a smart contract functioning as an oracle would appear as follows:

```
pragma solidity ^0.4.11;


contract Oracle {


    address oracle;
    uint[] public data;

    function Oracle() {
        oracle = msg.sender;
    }

    function reportData(uint newData)
    {
        require(msg.sender == oracle);
        data.push(newData);
    }
}
```

Obviously the oracle in itself does not resemble what is commonly understood in our contract law as a contract. The example given above contains no typical features of a contract. In addition, the smart contract does not include identifiable parties and therefore does not include anyone's expression of intent. Its only purpose is to collect data from one location and send it to another. This type of a smart contract functions specifically as a programme designed to relay data. This example quite clearly illustrates the problems caused by the discrepancies between the terminology and contents of smart contracts. Even though the entirety of the contracts which the oracle is a part of may resemble a typical contract, the oracle in itself would still be nothing more than a programme designed to relay data.

Case: Search Engine Optimisation

A slightly different example of a smart contract is a basic service level agreement. This type of contract could, for example, be used to estimate the success of search engine optimisation. In this scenario, a buyer looking to purchase search engine optimisation services has created a smart contract into a blockchain, specifying the optimisation services required. The buyer will deposit the offered amount of value

into the contract. A seller who wishes to enter into the agreement does so by also depositing an amount of value into the contract as collateral. Once the deadline specified in the terms of the smart contract is due, the contract will assess whether the buyer's domain is amongst the top three Google search results for the search term "example", conducted by a specified oracle. If the terms of the contract are met at the time of the deadline, the seller will receive both of the deposited sums. Conversely, if the terms are not met, both of the deposits will go to the buyer. The described smart contract could be written as follows:

```solidity
pragma solidity ^0.4.11;


contract GoogleSearchOracle {
    function getRanking(string url, string searchTerm) constant
returns (uint);
}

contract ServiceLevelAgreement {


    GoogleSearchOracle oracle = GoogleSearchOracle(0x8b208798
4b3b3f15450a644887f100d9559bb0cc);


    address buyer;
    address seller;

    uint price = 190 ether;
    uint collateral = 2 ether;
    uint maxAcceptedRank = 3;
    string domainName = "http://www.example.com/";
    string searchTerm = "example";
    // 2017-10-15 at 0 hours 0 minutes 0 seconds in Unix time
    uint deadline = 1508025600;

    function ServiceLevelAgreement() payable {
        require(msg.value == price);

        buyer = msg.sender;
    }

    // The contract can be canceled as long as it hasn't been
    // accepted by anyone
    function cancel() {
```

```
            require(msg.sender == buyer);
            require(!seller);

            selfdestruct(buyer);
        }

        function accept() payable {
            require(!seller);
            require(msg.value == collateral);

            seller = msg.sender;
        }

        function doSettlement() {
            require(seller);
            require(now >= deadline);

            // By default, send the deposit to the seller of the
            // service...
            address recipient = seller;
          // ...but, if failed to reach the agreed service level,
return the deposit to the buyer
            if (oracle.getRanking(domainName, searchTerm) > maxAc-
ceptedRank) {
                recipient = buyer;
            }

            if (!recipient.send(price + collateral)) {
                throw;
            }
        }
}
```

In this example, the buyer has drafted a contract-like digital instrument and deployed it in a public blockchain. This act can be interpreted as an indication of the buyer's willingness to enter into an agreement. The seller demonstrates the same willingness to enter into an agreement by depositing the predetermined sum of value into the contract. Such a construction is very similar to a tacit agreement and is therefore quite a clear example of how legal acts can be performed with smart contracts.

It is noteworthy, however, that although the smart contract in this example allows the contracting parties to align their incentives in such a way as to achieve their contractual goals, technically the arrangement itself does not involve any contractual obligations for the seller to optimise the search engine results. Essentially the contract constitutes a simple bet on the search result placement of a certain domain on a given date, at a given time. It simply then follows from this bet that the passivity of the seller in this respect would result in the loss of the seller's own deposit and the forfeiting of the buyer's deposit.[71]

Based on this example, when evaluating the legal position of smart contracts and the obligations and rights which they create for the parties involved, it bears significance how and between which parties the smart contract was created.[72] In light of our current legislation dealing with contract law, the casuistic nature of the evaluation is emphasised.

Case: Token Sale (a.k.a. Initial Coin Offering, ICO)

Smart contracts can also be used for purchasing shares in so-called token sales, or *initial coin offerings (ICO)*. The idea herein is somewhat analogous to crowdfunding applied to pre-seed venture capital funding rounds for start-ups. As funds are paid into the smart contract, tokens are transferred to the purchasing party to represent the ownership of shares. These tokens can be programmed to include several types of functionality, including dividends, voting rights and access to goods and services later on produced by the company.[73]

In this example, in order to raise funds for a start-up company, an issuer is offering to sell share-representing tokens for a predetermined price of 1 ether per token and offers to accept all purchases conducted before the set deadline. The smart contract could be drafted as follows:

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[71] Another perspective to the smart contract in this example is that of contractual penalties. It could be interpreted that the deposit required from the seller in order to enter the agreement constitutes a contractual penalty clause.

[72] Regarding the example, declaration of intent may manifest in different ways within the scope of the applied conclusion mechanism, depending on which party is the creator of the smart contract and which party is the one reacting to the smart contract. If a party of the arrangement does not act as the creator of the smart contract or react to it by making a payment or digital signature, their declaration of intent may be very difficult to prove.

[73] For further information on ICOs, see e.g. Conley 2017.

```solidity
pragma solidity ^0.4.11;


contract ICO {


    address tokenIssuer;
    uint collectedEther;
    uint minFunding = 2500 ether;
    mapping (address => uint) public balances;
    // 2017-10-15 at 0 hours 0 minutes 0 seconds in Unix time
    uint icoDeadline = 1508025600;

    function ICO() {
        tokenIssuer = msg.sender;
    }

    function mint() payable {
        require(now < icoDeadline);

        collectedEther += msg.value;
        balances[msg.sender] += msg.value;
    }

    function transfer(address receiver, uint amount) {
        require(fundingSuccessful());
        require(balances[msg.sender] >= amount)

        balances[msg.sender] -= amount;
        balances[receiver] += amount;
    }

        // If funding was successful, the token issuer may
withdraw
    // all deposits
    function withdrawFunding() {
        require(fundingSuccessful());

        if (!tokenIssuer.send(collectedEther)) {
            throw;
        }
    }

    // If funding failed, investors may withdraw their
    // investments back
```

```
        function withdrawInvestment() {
                require(now >= icoDeadline && collectedEther <
minFunding);

            uint investment = balances[msg.sender];
            balances[msg.sender] = 0;

            if (!msg.sender.send(investment)) {
                throw;
            }
        }

        function fundingSuccessful() private constant returns
(bool) {
            if (now >= icoDeadline && collectedEther >= minFunding)
{
                return true;
            }
            return false;
        }

        function payDividends() {
            ...
        }

        function vote() {
            ...
        }
    }
```

In this case, the issuer of the token sale has drafted a smart contract and publicly deployed it, specifying the offered price, the minimum funding threshold and the termination deadline of the offer. Investors wanting to engage in an investment arrangement with the issuer can do so by transferring their stake as cryptocurrency tokens into the smart contract. Once the termination deadline has been reached and the offer has expired, the smart contract will determine whether a sufficient amount of funds has been committed to the funding round. If the minimum threshold has been surpassed, the contract will release the funds transferred into the contract to the issuer of the token sale, and the funders will be issued share-representing tokens accordingly.

In this example, the expressions of intent of the parties are quite clear, and the contract can be seen to have been concluded tacitly. The issuer's expression of intent (offer) is manifested in the act of deploying the smart contract into a blockchain, and the funder's reciprocal acceptance takes form in the depositing of the funds into the smart contract. The situation can therefore be interpreted via the offer–acceptance

mechanism found in the Finnish Contracts Act such that the issuer has shown their willingness to enter into the contract by placing the smart contract into a blockchain, and the funder has reciprocated by transferring the funds. If the offer has been sufficiently identifiable then this interpretation is viable. The third example seems to reinforce the understanding that a smart contract can be a contract in the typical legal sense of the word, if an offer–acceptance mechanism can be sufficiently identified. This view is further reinforced when the example is interpreted analogously in comparison with the vending machine example.[74]

Conclusions and Discussion

Smart contracts can be drafted on very different bases and for entirely dissimilar purposes – not all of which meet the characteristics and the legal requirements of a contract. Based on the empirics in section "Can Smart Contracts Be Used to Perform Legal Acts?", however, it seems rather clear that legal acts *can* be concluded in the form of smart contracts. In this regard, the manifestation of intent through the exchange of performances appears to be of focal importance. A similar mechanism has been previously presented in the Finnish legal literature – namely, the vending machine, where the implicit nature of declarations of intent is highlighted in the formation of the contract. However, due to the fact that smart contracts are not specifically covered in the current legislation, legal ambiguity may arise as a consequence of their conceptual unconventionality.[75]

In addition to the ambiguity in regard to the letter of the law, smart contracts can also be subject to algorithmic ambiguity, so to speak. When co-operation is organised just by the programming code of a smart contract, trying to understand the true legal content of the arrangement on the basis of the programming code alone can be problematic.[76] Although this chapter has described three examples of smart contracts, in reality the number and the scope of possible applications may be practically

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[74] This type of a smart contract seems to include characteristics of a contract containing conditions precedent or subsequent. In so-called conditional sales, it can be agreed that the sale is only concluded if a certain future event takes place. Conditions subsequent refer to uncertain events. In this case the condition subsequent would manifest as the cancellation of the sale (and the return of the deposit to Y) in case the ICO fails to attract sufficient amounts of funding. For more about the conditions of a contract, see, e.g. Saarnilehto et al. 2012, pp. 401–402. Conditions and conditional sales will not be further discussed in this publication.

[75] For a similar interpretation from the Estonian perspective, see also Kõlvart et al. 2016, p. 145.

[76] Conversely, however, it is worth noting that if a traditional contract were to be created in code, this would require the contract to be arranged and presented as a process depicting interdependency: "if X, then Y, otherwise Z" (Mattila 2016, p. 15). Since the way in which traditional contracts are worded can often result in ambiguity, this new use of formulas can in at least some cases reduce the need for interpretation (Wright and De Filippi 2015, pp. 11 and 24–25). This kind of development can at best lead to significant reductions in the costs caused by drafting contracts and overseeing their execution.

infinite. The variety of smart contracts may cause various legal issues, the effects of which may be hard to anticipate at such an early stage.[77]

With the focus on such potential challenges, "soft law" arrangements, such as so-called dual integration systems[78] and systems based on various model agreements,[79] have already been developed to help prove the existence of a contract in the legal domain.[80] It is thus likely that smart contracts will first and foremost be utilised in the context of standard-form contracts and other kinds of simple contracts that do not involve ambiguous legal terms. Nevertheless, engaging in discussions about developing the legal doctrinal composition of smart contracts, both on the national as well as the European Union level, should be considered an equally important and topical approach in the matter.

In the literature on platform economy, boundary resources have traditionally been understood as technical tools used to lower the threshold for third parties to join part of a company's platform ecosystem. The perspective of technical tools, however, has yet to be applied to social boundary resources on a similar scale. Smart contracts are a clear example of how social boundary resources are developing in an increasingly technical direction. It is becoming increasingly difficult to draw a distinction between technical and social boundary resources of platforms. Social boundary resources should therefore be perceived as technical enablers, similarly to technical boundary resources.[81]

Contracts in themselves have also not been formerly perceived as boundary resources, in the sense that the network effects of a platform ecosystem could be boosted by opening up so-called *application contracting interfaces, ACIs* (cf. *application programming interfaces, APIs*). This would enable the creation of more

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[77] Such questions may regard, for instance, the existence of a contract or the verification of its content (code vs the parties' true intent) as well as possible unintended errors left in the code. For such errors related to the intent of the parties, it is likely that section 32(1) (concerning the so-called error in declaration) of the Finnish Contracts Act can be applied if there is a conflict between content and intent due to an error in the contract code. See, e.g. Hemmo 2003, p. 396.

[78] Dual integration: "The idea of dual integration is to allow users to be able to have the certainty of having a real world contract which can be taken to a court and enforced using established dispute resolution processes in the jurisdiction(s) of the user(s) while also using a smart contract as the primary mechanism for administering the data-driven interaction which attends to the agreement between the parties" (https://erisindustries.com/components/erislegal/ (23 August 2016).

[79] Out of these openly developed solutions, the perhaps most significant one is Common Accord: "[…] an initiative to create global codes of legal transacting by codifying and automating legal documents, including contracts, permits, organisational documents and consents. We anticipate that there will be codes for each jurisdiction, in each language. For international dealings and coordination, there will be at least one 'global' code". Well-known lawyer and crypto-oriented legal researcher Primavera De Filippi is part of the Common Accord group. See http://www.commonaccord.org/ (23 August 2016).

[80] One way to solve possible issues is by aiming to create general conditions of contract such as INCOTERMS or Creative Commons for the use of smart contracts. One such example is the Simple Agreement for Future Tokens (SAFT) initiative which aims to design a legally sound framework for carrying out initial coin offerings in accordance with the US legislation. See https://saftproject.com/ (5.12.2017).

[81] For comparison: Gawer 2009; Ghazawneh 2012; Ghazawneh and Henfridsson 2013.

highly automated digital contracting mechanisms, process automation that reaches further beyond companies' own information systems, as well as more automated and more dynamic networks of contracting parties.

In general, smart contracts can be expected to disrupt the development of the platform economy by enabling unprecedented ways to co-operate in open platform ecosystems. As for managerial implications, companies should address the following three considerations:

1. How can smart contracts be used to lower the threshold for third parties to enter the company's platform ecosystem, in the same manner as technical boundary resources have been used for opening interfaces and offering ready-to-go tools for development?
2. In cases where companies have several contracting interfaces towards their clients, suppliers and other interest groups, which interfaces are suitable for the use of smart contracts with each respective party?
3. If several parties are subjected to the same smart contract in a vending-machine-like manner, are contractual arrangements required by successful business strategy becoming more fragmented, if individual deliveries are comprised of several constituent parts of separate suppliers?

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