

INTERNATIONAL JOURNAL OF
DIGITAL AND DATA LAW

REVUE INTERNATIONALE DE DROIT
DES DONNÉES ET DU NUMÉRIQUE



 **IMODEV**
LES ÉDITIONS

Vol. 11 - 2025

ISSN 2553-6893

International Journal of Digital and Data Law
Revue internationale de droit des données et du numérique

Direction :
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ISSN : 2553-6893

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The **International Journal of Digital and Data Law / Revue Internationale de droit des données et du numérique (RIDDN)** is an academic journal created and edited by Irène Bouhadana and William Gilles at IMODEV, the Institut du monde et du développement pour la bonne gouvernance publique.

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- 2) the *International Journal of Digital and Data Law / la Revue internationale de droit des données et du numérique (RIDDN)* [ISSN 2553-6893]

SMART CONTRACTS: ADVANTAGES AND LIMITATIONS FROM A CONTRACTUAL PERSPECTIVE

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The word *smart* has been added to common everyday terms to indicate the use of technological innovation, such as smart TV, smartcity, smartphone, smartwatch, among others. With the advent of the Internet and the continuously advanced technological development, there is, as a result, the digitalization of human relations on a large scale; therefore, the impacts on the Law in view of these new realities are unquestionable.

The legal experience of the contract is fascinating. It reflects how two great forces, human necessity and individual freedom, guide at the same time, "in their multiple forms of action, the whole complex of human operationalization"¹ in their private relationships. The contract, in general, as a kind of legal business, requires a meeting of wills endowed with creative force to regulate private interests. The parties, when entering into a contract, declare that they agree with the way they should conduct themselves in relation to each other, in order to achieve common interests, through the constitution, modification or extinction of obligations².

In the meantime, when contracting parties choose to use the smart contract as a contractual mechanism for certain clauses, they take into account contractual risk, trust, and the search to ensure the fulfillment of obligations beyond traditional forms. Time, risk and will are the fundamental elements of the analysis of contractual risk management³. A contract is used as a mechanism to reduce the

¹ Rosa Maria de Andrade NERY, Nelson NERY JR., *Instituições de direito civil*, Vol.. II: *Das obrigações, dos contratos e da responsabilidade civil*, 2. ed., Thomson Reuters, 2019, pp. 487-488.

² *Ibid.*, p. 31.

³ Gustavo TEPELINO, Rodrigo da Guia SILVA, *Inteligência artificial, smart contracts e gestão do risco contratual. O Direito Civil na era da inteligência artificial*, Thomson Reuters Brasil, 2020, p. 373.

uncertainty of the performance of the agreed obligations, as it describes the object of the legal transaction, the respective obligations of the parties and the possible sanction in case of default.

The smart contract can be defined as a new way of constituting and fulfilling contractual obligations in lines of a programming code that execute certain transactions pre-established in the contract when a foreseen condition is met. It was conceived by Nick Szabo in 1994 from the conception of an automatic vending machine, in which the contract should work in a similar way.

For the scientist, a contract should work in the same way, in which the implementations of some contractual clauses work in an automated way, without requiring human action in the verification of the fulfillment of the contractual condition, with the use of computer technology. As a consequence, this would make the default costly and unwanted, that is, greater trust between the parties and better planning in the business⁴.

With the development of bitcoin⁵ and blockchain technology, the smart contract has become viable. It then became possible to transform contractual clauses into computer language in order to create lines of computer program code, then insert them into a database that stores information encoded in immutable and decentralized blocks. Thus, to ensure the execution of the obligations provided for when the established conditions are met, based on the information made available and authorized, in an immediate, autonomous and reliable manner. Like all technological innovations, there are advantages and limitations to the smart contract, which will be better addressed below.

§1 – ADVANTAGES OF A SMART CONTRACT

Code is law. This computer notion is linked to the logic *if x, then y*, present in the smart contract. The smart contract presents itself "as a contractual technological innovation that imposes relevant

⁴ "The cost of doing business globally is increasingly dominated by issues of jurisdiction, security, and trust: the cost of developing, maintaining, and securing our relationship. [...] The basic idea behind smart contracts is that many kinds of contractual clauses (such as collateral, bonding, delineation of property rights, etc.) can be embedded in the hardware and software we deal with, in such a way as to make breach of contract expensive (if desired, sometimes prohibitively so) for the breacher." - Nick SZABO, *The Idea of Smart Contracts*, 1997:

[<https://www.fon.hum.uva.nl/rob/Courses/InformationInSpeech/CDROM/Literature/LOTwinterschool2006/szabo.best.vwh.net/idea.html>] (accessed on: Feb., 5, 2025).

⁵ When Satoshi Nakamoto presented the existential foundations of Bitcoin and blockchain technology in 2008, he criticized the uncertainties and insecurities that hover over contracts made in e-commerce. For Nakamoto, in e-commerce at the time, financial institutions, as intermediaries in the relationships between seller and buyer, would not be able to ensure the fulfillment of obligations, therefore, this burdened economic agents and prevented to a certain extent the democratization of access to global e-commerce⁵. Adriana SILIPRANDI, Fernando LOPES, *Blockchain, Bitcoin e Smart Contracts - a revolução dos ativos digitais*, Tirant Lo Blanch, 2019, p 105.

changes in the form of contracting and especially in the way of executing the agreed covenants"⁶, in which the agreed obligations are written in computer language under the logic *if x, then y*, because if a certain event happens or obligation is fulfilled or not fulfilled, the consequence will happen automatically, that is:

“The execution is automatically imposed, and there is no way to prevent it, and they are therefore characterized as self-enforceable. In addition, they cannot be influenced by external factors, so it is argued that there is greater security and trust between the parties”⁷.

The so-called intelligent software can “consist of a useful instrument for contractual risk management, especially by virtue of the possibility, at least in theory, of designing each software (and the respective *modus operandi*)”⁸ to meet the wishes of the contracting parties in view of previously stipulated future situations. The use of intelligent software in contracts enables a continuous adaptation of previously agreed solutions for contractual risk management without requiring the parties to review the contract or make amendments to adapt because it is carried out automatically.

The operationalization of the smart contract through blockchain occurs as follows: a programmer transforms the contractual clauses into computer language in order to create lines of computer program code, then inserts them into a database that stores information encoded in immutable and decentralized blocks, thus ensuring the execution of the obligations provided for when the established conditions are met, based on the information made available and authorized, in an immediate, autonomous and reliable way⁹.

To identify whether a foreseen contractual condition has been met, the conditional nature of the smart contract is satisfied primarily with *if* conditions, which correspond to one or more outcomes¹⁰ under the logical language *if x, then y*, in which the fulfillment and imperative execution of the contract is translated into the automatic fulfillment of the obligation, having as its discretion the code of the smart contract itself¹¹.

Smart contract operability is related to the notion of self-enforcement, that is, self-execution of obligations without requiring human action. Consequently, the ease and agility with

⁶ Antônio Carlos EFING, Adrielly Pinho dos SANTOS, “Análise dos smart contracts à luz do princípio da função social dos contratos no direito brasileiro”, *Direito e Desenvolvimento*, Vol. 9, n° 2, aug. 2018, p. 54:

[<https://periodicos.unipe.br/index.php/direitoedesenvolvimento/article/view/755/554>], (access on: Feb. 5, 2025).

⁷ *Ibid.*, p. 54.

⁸ TEPEDINO; SILVA, 2020, p. 383.

⁹ Carla Arigony de CARVALHO, Lucas Veiga ÁVILA, “A tecnologia Blockchain Aplicada aos Contratos Inteligentes”, *Revista Univem*, 2019:

[<https://revista.univem.edu.br/emtempo/article/view/3210>] (access on: Dec. 8, 2023).

¹⁰ CARVALHO; ÁVILA, 2019.

¹¹ *Ibid.*

which the execution of the obligations scheduled to be executed by the smart contract occurs is undeniable, as it seeks to mitigate the possibility of contractual default due to its self-execution¹². Max Raskin illustrates this advantage of self-execution in the following situation: in a monthly subscription car rental contract¹³, suppose that, instead of the car owner's computer program controlling the fulfillment of the agreed obligations, some or all of the contractual clauses have been written through a smart contract.

In this scenario, the parties would be using blockchain technology, which is neutral, that is, it does not present factors that can interfere with the impartiality of the analysis of the execution of the contract. As a result, if the lessee fails to comply with its obligation to pay the owner at the agreed time and manner, there will be, for example, a mechanism activated by the smart contract that will prevent the car's engine from working; On the other hand, if the smart contract identifies the payment by the lessee, the car will continue to work.

Thus, neither party, lessor and lessee, will need to monitor the other party's contractual compliance, as blockchain technology in a smart contract is able to do this inspection in a disinterested and impartial way, increasing trust between the parties regarding the terms of the contract. Raskin concludes that the self-executing of the smart contract is what makes it smart, as it manages to do more than the traditional contract through blockchain technology in being able to stimulate contractual compliance in a neutral, independent and free of self-help problems¹⁴.

Transparency is a basic principle in the smart contract. The contractual conditions are available at all times to the contracting parties and cannot be changed after being stored in the blockchain, nor contain information that is not known to the other party, which results in an increase in trust between the parties about what was agreed.

The immutability of the smart contract can also be considered as an advantage, as it allows predictability over the course of contractual execution and the security that the conditions provided for will be applied regardless of the control or will of one of the parties or influenced by external factors, which in a certain way provide greater security and confidence to the parties¹⁵.

The security of the veracity of the information that is stored in the blockchain is also supported by its immutability, or at least by the difficulty of carrying out an improper transaction without some full node identifying that it is a transaction that violates the consensus protocol.

¹² TEPEDINO; SILVA, 2020, p. 389.

¹³ Max RASKIN, "The Law and Legality of Smart Contracts", *Georgetown Law Technology Review*, Washington, Vol. 1, n° 2, pp. 305-341, 2017: [https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2959166] (access on Feb., 5, 2025).

¹⁴ *Ibid.*

¹⁵ EFING; SANTOS, 2018.

The difficulty in changing the information contained in a block within a blockchain related to a smart contract consists in the fact that the terms of the contract cannot be easily changed by one or more people and are programmed independently, without the need for a third-party intermediary to ensure trust in the business. In this sense, suppose that a buy-sell smart contract provided for the obligation of A to pay an amount to B with a certain date and time. If millions of computers verify that A paid B on the agreed date and time, it is possible to say with a large degree of certainty that the contractual obligation has been fulfilled as agreed, as is the case with continuous storage on the blockchain between its users.

In addition, transactions made through blockchain do not require a third party to mediate the relationship or check the implementations of the contractual conditions; in other words, “the validation of transactions is done by network nodes, using cryptography”¹⁶ which give greater confidence and security to the parties.

Another advantageous factor in the smart contract is the reduction of costs for its formation and implementation. The first point is related to its decentralization, which consequently contributes to having one less party in the legal relationship, less one cost involved, as it does not require the intermediation of third parties in order to ensure confidence in the business and supervise the execution.

The smart contract itself can be responsible for automatically releasing the agreed payment and complying with other contractual provisions when certain conditions are met, which also automatically reduces the costs and time involved in legal transactions that have clauses in a smart contract, especially when dealing with legal transactions that are agreed between people in different locations.

In short, the smart contract presents itself as a potential instrument in the management of contractual risk with the advent of blockchain technology due to two predominant factors: the automatic execution of services and the application of self-executing measures as remedies for contractual default¹⁷.

§ 2 – LIMITATIONS OF A SMART CONTRACT

The expression smart contract can lead to a misunderstanding of the term, in the sense of understanding that “all instruments formalized with the use of this automated execution technology would necessarily be contracts”¹⁸, which is not true. Not all smart contracts can be considered contracts from a legal point of view, “because they are often nothing more than automation of objective

¹⁶ *Ibid.*

¹⁷ EFING; SANTOS, 2018, p. 387.

¹⁸ Gabriela de Sá Ramires WANDERLEY, “Smart Contracts: Uma nova era do direito obrigacional?”, *Revista de Direito e as Novas Tecnologias*, Vol. 7, Apr./Jun. 2020.

characters of a contract”¹⁹, which clauses require a value judgment or interpretation, such as applicable law, subjective issues, these are not capable of being codified.

Nick Szabo proposed the drafting of the smart contract from an optimistic perspective of the possibility of replacing the traditional paper contract with an automated contract, due to the reduction of operational costs by increasing trust between the parties in the automation of contractual obligations. On the other hand, Patrick Murch, an affiliate of Harvard's Berkman Klein Center for Internet and Society, clarifies that "the two things about smart contracts are that they are dumb and they are not contracts"²⁰, “Smart contracts voraciously need data to do their job and someone needs to provide it”²¹.

The smart contract, in the words of André Feiteiro, consists of only codes that read and write on a blockchain and necessarily require a human to enter the data for the smart contract to be able to perform its functions. From this finding, André Feiteiro explains that portraying the smart contract as something stupid means recognizing the deficiency of the aforementioned legal instrument to perform effectively, alone, when the data necessary to perform a task is not inserted in the specific chain²².

New technologies are only really effective when they add something to traditional systems, given the existence of some gap that technology is able to fill and bring agility. For Feiteiro, blockchain technology only makes sense when several parties want to enter into a legal deal, have a certain degree of distrust among themselves and do not want to put a third party as an intermediary to ensure the desired reliability²³.

In this sense, one of the limitations experienced with the smart contract is related, first of all, to the language by computer code inherent to its nature. The code language is written in formal semantic language, consequently, it is reduced to binary instructions. The code is written with 0 and 1. Thus, it may be that in certain contracts that require a higher degree of complexity, which specificity is a determining factor, the computational coded language is not able to bring this specificity, because it is limited to binary instructions, yes or no²⁴.

¹⁹ CARVALHO, 2019.

²⁰ Brian Patrick EHA, “The race to connect smart contracts to the real world”, *American Banker*, (2017). [www.americanbanker.com/news/the-race-to-connect-smart-contracts-to-the-real-world] (access on: Aug., 27, 2023).

²¹ *Ibid.*

²² *Ibid.*

²³ “Distributed ledger Technologies, and blockchain specifically, are as worthy to the provision as its capacity to actually impact the efficiency – in number or quality – of the provision of such service. If blockchain technology is used in a situation in which is it not able to effectively reduce costs or enhance efficiencies, in general, then it is worthless when compared to the traditional means of provision”. *Ibid.*

²⁴ “It is relevant to note that the rigidity of code language is a limitation, that the inability to make a fair judgement on ambiguous terms and a blind execution of those terms cannot possibly make the performance phase of a contract easier or even “offer a tool to

There are circumstances in which the smart contract is not able to make the necessary value judgment to say whether the contractual obligation was in fact performed or not, or with the expected quality. For example, in a service contract for the renovation of a kitchen. The company hired to perform the service can state in the contract that it has complied with its obligation to automatically receive the amount of the consideration; however, the smart contract is limited in judging the quality of the service, in which said judgment demands elements of social ontology that the code cannot accomplish²⁵.

In the field of smart contract functionality, there are some risks and restrictions that should be noted. The technology behind the smart contract demands that the obligations agreed upon be provided for with the greatest degree of clarity and detail possible, because "the programming of the smart contract must discriminately contemplate all the factors considered relevant by the parties, with the maximum possible detail, under penalty of compromising the operation of the software as programmed"²⁶. In addition to the fact that "there is a significant risk of a legal nature: the peculiar way smart contracts work can make it difficult (or even unfeasible) to consider norms and values of imperative incidence on the generality of legal relationships"²⁷.

The result of the need for clarity, objectivity and specificity of the agreed obligations and circumstances contemplated in the smart contract, so that it can self-execute them in the intended way, is the reduction of the "breadth of the set of hypotheses and nuances that encompass such principles and standards of conduct"²⁸. Gustavo Tepedino and Rodrigo da Guia Silva add to this observation, for example, the difficulty of the smart contract to apply the principles of human dignity, the social function of the contract and objective good faith or the theory of substantial performance "to perceive the seriousness of contractual execution mechanisms that are intended to be immune to axiological considerations"²⁹, since the code is not capable of making this value judgment.

It may also be that there is a distortion between the actual will of the parties and the translation of it into coded language, since, as demonstrated earlier, the language of the smart contract is written under the logic *if x, then y*. In this way, possible ambiguities in natural language are mitigated in coded language, as a means of ensuring the self-execution of the provision programmed by the smart contract.

solve ambiguity problems". (André FEITEIRO, "The Complementary but not Alternative Utility of Smart Contracts", *Revista de Direito e as Novas Tecnologias*, Apr./Jun. 2020).

²⁵ *Ibid.*

²⁶ TEPEDINO; SILVA, 2020, p. 389.

²⁷ *Ibid.*, p. 389.

²⁸ Jorge Feliu REY, "Smart Contract: conceito, ecossistema e principais questões de direito privado", *Revista Eletronica Direito e Sociedade*, Vol. 7, n° 3, 2019. p. 18.

²⁹ TEPEDINO; SILVA, 2020, p. 390.

However, it is highlighted that not every obligation is capable of being executed by a smart contract. The coded language of the smart contract is limited in some functions, so it is not applicable to all legal transactions or contractual obligations³⁰. Consequently, the agreed obligations that require a judgment of discretion on the part of the contracting parties cannot be written in coded language; only obligations that dispense with this discretionary judgment may be included in a smart contract, such as: "the setting of a deadline for the transfer of cryptocurrencies for price payment; implementation of a price adjustment index; definition of the value of the share for the exercise of a call option – and which object is subject to digital representation" among others³¹.

In addition, the environment that ensures trust between the parties in a smart contract is limited to the operations performed with the data that is on-chain. This means that, as much as a smart contract is able to regulate information that is on-chain and off-chain, transactions that are off-chain, such as data stored in the cloud, the smart contract is not able to ensure such a secure environment:

“These outside references are called oracles and they are “the interface between the contract and the outside”. A smart contract executed when and if a certain event occurs: the occurrence of the relevant event is represented in data. Data lies in source of information. Oracles gather data from sources of information and provide it to smart contracts to self-execute accordingly”³².

In other words, the fact that the smart contract mostly requires access to off-chain data through the so-called oracles, the reliability of the information may be somewhat compromised in view of the vulnerability of said data, given that “because the instructions coded in smart contracts are executed as a consequence of data inputs, the vulnerability of smart contracts lies in the reliability of oracles”³³.

In the most complex smart contracts, which require off-chain information to perform their obligations or extract information, Jorge Feliu Rey ponders that for this to occur correctly, the dependence on oracles is a limiting factor. For example, a smart contract with deferred execution in time, in which it will be necessary to obtain the value of a company's share at a future date to self-execute a pre-established obligation. This information will be acquired through an oracle and later integrated into the smart contract³⁴.

³⁰ Aline de Miranda Valverde TERRA, Deborah Pereira Pinto dos SANTOS, “Do Pacta Sunt Servanda ao Code is law: breve notas sobre a codificação de comportamentos e os controles de legalidade nos smart contracts”, in: TEPEDINO; SILVA, 2020, p. 400.

³¹ *Ibid.*

³² FEITEIRO, 2020.

³³ *Ibid.*

³⁴ REY, 2019. p. 15.

For the reasons given, it is possible that there is information provided by oracles that is not accurate; therefore, "the automation characteristic of smart contracts will tend to lead the contractual execution to a result different from that desired by the parties without being configured, in principle, the fault of any of the contracting parties"³⁵, which compromises the performance of the obligation by the intelligent contract.

In addition to the possible limitations described above, it is worth mentioning the inevitability of programmed effects within the framework of the smart contract. This is one of the advantages of the smart contract of its inevitability, but it also represents a limitation in case of mismatch between the real will of one of the parties and what has been translated into coded language. In this case, "the automation characteristic of smart contracts will tend to lead the contractual execution to a result different from that desired by the parties without the fault of any of the contracting parties being configured, in principle"³⁶ and that it will not be able to rely on actions commonly sought in the Judiciary to prevent the execution of the pre-programmed obligation.

Consequently, the party that feels harmed may only count on the intervention of the Judiciary after the implementation of the obligation by the smart contract for the purpose of reparation or restitution³⁷.

CONCLUSION

All in all, smart contract presents itself as a technological innovation that stands out as an especially interesting tool to facilitate transactions in an increasingly digitized world. It presents itself as a potential instrument in the management of contractual risk due to two predominant factors: the automatic execution of installments and the application of self-executing measures as remedies for contractual default³⁸. However, as it is a contractual mechanism for specific circumstances and not a new generalized form of contracting, not applicable to any and all contractual obligations, the parties should jointly consider the limitations of

³⁵ TEPEDINO; SILVA, 2020, p. 390.

³⁶ *Ibid.*

³⁷ "In this context, it seems highly recommended to carefully reflect on the doctrinal reflection on the conformity of the automation of execution promoted by smart contracts to constitutional legality. The issue is sensitive and demands a critical analysis of the sphere of autonomy recognized to the parties to remove or modulate the exceptions of defense ordinarily opposed, with a view to suspending or interrupting the enforceability of the performance. Without prejudice to this necessary reflection, it is worth noting that some possible alternative solutions to face these issues are already being considered in doctrine. This is the case, for example, with the propositions to include a self-destructive or suicidal code capable of temporarily suspending or permanently terminating the operation of the smart contract, or to predefine qualified users with the power to interfere in the smart contract. These are propositions that have not yet been fully developed or tested, but which corroborate the urgency of the reflections indicated". (TEPEDINO; SILVA, 2020, pp. 391-392).

³⁸ EFING; SANTOS, 2018, p. 387.

establishing contractual compliances through a smart contract, to identify if in fact this is the best alternative to achieve the objective of the contract.

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