

The Role of Intelligent Agents in Concluding Smart Commercial Contracts within the Blockchain Era: From Digital Will to Automated Contracting

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Abstract:

The integration of blockchain, smart contracts, and AI-driven intelligent agents is transforming legal and economic systems. Smart commercial contracts now extend beyond automated drafting and execution, as intelligent agents can negotiate, analyze data, make decisions, and finalize agreements autonomously on behalf of principals. This development creates significant legal challenges, particularly in determining contractual will, attributing intent, and assigning liability for algorithmic or technical errors. It also raises questions about the evidentiary value of such contracts before courts and the resolution of conflicts of laws in decentralized, cross-border environments.

This study explores the role of intelligent agents in shaping smart contracts within the digital economy by examining both theoretical underpinnings and practical applications. It evaluates the suitability of traditional agency principles, potential liability models, and issues of consumer and data protection. Ultimately, the findings highlight

the urgent need for a clear legal framework that reconciles innovation with legal certainty to protect contracting parties in the digital age.

Keywords: Blockchain, Commercial Contract, Intelligent Agent, Smart Commercial.

INTRODUCTION

The business world is undergoing a qualitative shift driven by the convergence of blockchain technologies, smart contracts, and artificial intelligence capable of making semi-autonomous decisions—known as the “intelligent agent.” The conclusion of commercial contracts is no longer dependent solely on traditional signatures or the exchange of communications between natural or legal persons; algorithms and self-learning software have become active parties in receiving offers, analyzing terms, conducting automated negotiations, agreeing on contractual clauses, and executing them automatically through embedded code on the blockchain.

Before this technological and digital revolution, contract formation required the physical presence of parties or the exchange of their consent in writing or electronically. Recent developments, however, have enabled intelligent agents to search for optimal conditions, negotiate terms, and even autonomously conclude contracts once data alignment is achieved. This technological shift raises profound legal questions about the concept of contractual will, the attribution of actions to principals, the extent to which intelligent agents may represent natural or legal persons, and the limits of liability in cases of algorithmic errors or bias—alongside issues of evidentiary value, conflict of laws, jurisdiction, consumer protection, and data privacy.

Blockchain—being a distributed ledger resistant to tampering—offers transparency, traceability, and trust without a central intermediary. Smart contracts enable the automatic execution of contractual terms once predefined conditions are met. With intelligent agents entering the scene, the generative and decision-making dimensions expand: beyond execution to the very stage of

contract formation, from gathering market information, assessing risks, and drafting proposals, to accepting or rejecting offers based on machine learning algorithms.

The importance of this study lies in addressing the intersection between law and technology, where practice evolves faster than legislation. E-commerce companies, supply chains, digital asset markets, and decentralized platforms are already investing in solutions built on intelligent agents and smart contracts. This reality compels legislators and business courts to develop precise legal standards regulating representation, ensuring protection and contractual balance, while enabling responsible innovation. A clear conceptualization of the intelligent agent's role in contract formation will assist economic actors in designing technical and legal governance mechanisms that reduce disputes and enhance transactional certainty.

Accordingly, the issue of “Concluding Smart Commercial Contracts through Intelligent Agents in the Era of Blockchain Technology” is not merely technical or legal; it is a crossroad of law, technology, and the social philosophy of transactions. It is a debate on human will in the digital age, on the limits of algorithmic autonomy in creating obligations, and on the future of legal systems in the face of accelerating innovation. Hence, this research seeks to address core questions and propose a balanced legal framework that reconciles innovation with legal certainty.

Research Problem:

Hence, if the conclusion of commercial contracts has traditionally been based on the meeting of two conscious human wills, how can this fundamental principle be reconciled with the notion of a ‘digital will’ generated automatically by the intelligent agent through algorithms embedded within the blockchain environment? And can this digital will be legally recognized as a valid expression of the principal's will, with all the ensuing effects and obligations, or does the matter necessitate a reformulation of the traditional rules of contract to adapt to the nature of automated contracting?

Previous Studies:

Derrbal Siham, "The Intelligent Electronic Agent and Its Effective Role in Enhancing E-Commerce Transactions," *Journal of Law and Interdisciplinary Sciences*, Vol. 4, No. 3, 2025.

The Adopted Methodology:

To address this research problem, the study relied on the comparative analytical method by analyzing the legal provisions related to contract theory in law and comparing them with the technological developments associated with smart contracts and intelligent agents. The research also adopted the descriptive method in presenting the fundamental technologies of blockchain, smart contracts, and the functioning of intelligent agents, in addition to anticipating the future implications of these applications on the legal system. This methodological overlap makes it possible to highlight the gap between traditional legal provisions and contemporary technological practices, while proposing reform-oriented solutions that respond to digital developments.

Research Plan:

1. The Legal Nature of the Intelligent Agent in Concluding Smart Commercial Contracts

1.1 The Concept of the Electronic Agent and Blockchain Technology

1.2 Types of Electronic Agents and Their Preparation

1.3 The Legal Characterization of the Intelligent Agent between Electronic Personality and Technical Nature

2. The Evidentiary Value of Concluding Smart Commercial Contracts and Their Legal Effects, between the Traditional Theory of Contract and Intelligent Mechanisms

1.1 The Extent to Which Traditional Contract Rules Accommodate the Mechanism of Automated Conclusion

1.2 Types of electronic agents and how to set them up

1.3 Legal Challenges Related to the Evidentiary Value of Contracts Concluded through the Intelligent Agent

1. The Legal Nature of the Intelligent Agent in Concluding Smart Commercial Contracts

The digital revolution has introduced new features in the regulation of legal and commercial relationships, where interactions are no longer limited to traditional human parties. Instead, advanced technologies have emerged, foremost among them the intelligent agent powered by artificial intelligence, and blockchain technology, which provides a secure and transparent environment for recording transactions. The combination of these two innovations has given rise to smart contracts, regarded as a new mechanism for the conclusion and self-execution of obligations. Accordingly, examining the concept of the intelligent agent and the technological foundations of blockchain constitutes a fundamental entry point for understanding the challenges and future prospects facing the legal system amid digital transformation. Legal scholarship in this regard emphasizes that addressing any legal concept requires a clear understanding of its definition and parameters. On this basis, we shall set out the concept of the electronic agent and blockchain technology from both legal-doctrinal and technological perspectives.¹

1.1 The Concept of the Electronic Agent and Blockchain Technology

1.1.1 The Concept of the Electronic Agent

A. Doctrinal Definition

The electronic agent is considered one of the most prominent applications of artificial intelligence technologies. It is a special software program distinguished by its ability to act autonomously in performing the tasks assigned to it. In the technical literature, it has been referred to by several terms, such as Intelligent Agent, Robot, and sometimes Task-Based Robots—often abbreviated as Taskbots

or simply Bots. However, the most widely used term in this context remains Electronic Agent.

It is noteworthy that some Arab legislations have adopted the use of the term “Automated Intermediary” in the laws governing electronic transactions as a synonym for “Electronic Agent.” This terminology is relatively new to Arabic legal language, as it had not been employed in traditional legislation. The term refers to the intermediary or electronic agent responsible for concluding and executing transactions via the Internet. Its usage first appeared in Arabic documents issued by the United Nations Commission on International Trade Law (UNCITRAL), before being incorporated into certain national laws—such as the Dubai Electronic Transactions and Commerce Law of 2002 (Articles 2 and 15(b)), and the Jordanian Electronic Transactions Law (Article 2). Conversely, other legislations refrained from adopting this term, including the Egyptian Electronic Signature Law of 2004 and the Tunisian Electronic Exchanges and Commerce Law of 2000.²

Among the most important doctrinal definitions addressing this term is that provided by Professor IRENE Kafeza, who defined it as: “An intelligent electronic agent is a program that performs various tasks for the benefit of the user”.³

It is also defined as: “A program that undertakes the execution of diverse operations on behalf of the user in order to achieve his objectives, while enjoying autonomy in the course of doing so.”⁴

From another perspective, Professor Sherif Mohamed Ghanem defined it as: “A computer program that performs a specific task on behalf of the person using the computer, while enjoying a certain degree of autonomy in carrying out this task, without requiring the direct intervention of the person it represents.”⁵

It has also been defined by some scholars in terms of its purpose while simultaneously highlighting its characteristics. One of the most notable definitions is that provided by Krupanski, who described it as: “A computer program that operates to achieve specific objectives

within a dynamic environment where change is natural, acting on behalf of other computational or human entities over an extended period of time, without direct and continuous supervision or control, and with a high degree of flexibility and creativity in the manner in which it seeks to transform objectives into tasks.”⁶

Some jurists have defined it as “a computer program that performs a specific task on behalf of the person using the computer, with a degree of autonomy in carrying out that task, such that it does not require direct intervention from the person it represents”.

Others have defined it as “a computer program prepared by electronic means for the purpose of automatically executing a specific procedure or responding, wholly or partially, to an instruction relating to the transmission of an electronic data message, without the need for human intervention”.⁷

It is noted that this latter definition is partially derived from the definition provided in the U.S. Uniform Electronic Transactions Act (UETA) of 1999.

B. Technical Definition

From a technical perspective, the intelligent agent is defined as an advanced computer program based on artificial intelligence algorithms and self-programming, designed to perform specific tasks independently of direct human intervention. This agent is characterized by its ability to receive data, process it, and make decisions or execute actions according to a set of pre-programmed rules or those acquired through machine learning. Owing to these features, the intelligent agent has become one of the main tools for automating electronic transactions, as it can interact with complex digital environments in a way that simulates human behavior.

The intelligent agent is also distinguished by its capacity for self-adaptation, enabling it to adjust its behavior in response to surrounding technical or economic variables. This makes it fundamentally different from traditional software, which is limited to rigid tasks. It may operate entirely independently or within networks

based on advanced technologies such as blockchain, which grants it additional capabilities in ensuring transparency, reliability, and speed in executing operations.

Accordingly, the technical definition of the intelligent agent places it in an intermediate position between ordinary computer programs and autonomous intelligent systems capable of decision-making without direct human supervision.⁸

C. Characteristics of the Intelligent Agent

Among the most important characteristics of the intelligent (electronic) agent are the following:

Autonomy: The electronic agent is characterized by its ability to act independently. Its behavior relies on experiences gained from its own operations or through the exchange of data with other agents. This feature stems from the way it was programmed by humans through a set of inputs and outputs that enable it to make context-appropriate decisions. Accordingly, it operates without direct human intervention or external control and exercises a degree of self-governance over its actions and internal state, which grants it the capacity to perform its tasks completely autonomously, free from interference by another person or even by another electronic agent.

Reactivity: The electronic agent possesses the ability to perceive its surrounding environment and monitor any changes affecting its various elements. This enables it to respond immediately to developments on the internet, such as the emergence of new products or services, price reductions, or the creation of new virtual stores. These variables allow the agent to adjust its sales and purchase offers in terms of price, guarantees, and after-sales services. Thanks to this adaptability, the intelligent agent can interact with its environment automatically and respond in real time to evolving circumstances.

Social Communication Ability: The electronic agent is also distinguished by its ability to interact and communicate with other agents, whether electronic or human. It achieves this through

specialized communication languages within computer systems, enabling it to exchange data and information with high efficiency.⁹

Initiative and Proactive Action: Unlike traditional programs that require user intervention for activation and guidance, the electronic agent possesses the ability to sense changes in its environment and then take the initiative by extending offers to consumers or submitting acceptance to other parties. This feature is based on its advanced capabilities in collecting and analyzing data related to goods or services in terms of type, price, and specifications, in addition to recording consumer information such as email addresses and product lists. It is further distinguished by its ability to rapidly navigate across different websites, which significantly enhances its effectiveness in completing digital transactions.¹⁰

D. Distinction Between the Electronic Agent and the Traditional Agent: The electronic agent differs from the traditional agent in several fundamental aspects, among them:

The electronic agent is created by a natural person who programs a computer system specifically designed to perform electronic transactions, including the conclusion of legal acts in the name and on behalf of the principal, whether the programmer acts in his personal capacity or as a representative of a legal entity. By contrast, the traditional agency is established through an explicit agreement between the principal and the agent, whereby the latter is authorized to carry out certain legal acts on behalf of the principal.¹¹

In the case of the electronic agent, the intention to contract is embodied at the moment of programming the computer in a specific manner, which constitutes a prior expression of the principal's will to issue an offer or acceptance, thereby clearly revealing the intent to conclude a contract. In contrast, the traditional agency presumes the direct meeting of the agent's will with that of the other party at the time of concluding the legal act to produce the desired effect.¹²

The electronic agent cannot exceed the limits of its agency, as it operates strictly within the pre-defined programming framework. On

the other hand, the traditional agent may exceed the scope of the granted authorization if acting beyond the boundaries of the agency.

Since the electronic agent is merely a computer program, the agency can only ever be explicit, unlike the traditional agency, which may be either explicit or implicit depending on the circumstances¹³.

The traditional agency typically terminates upon the expiration of the agency agreement, the death of the principal, or the principal's bankruptcy. Conversely, the electronic agency ends upon the deactivation or deletion of the program, or through modifications to the stored instructions that prevent it from continuing to perform the functions of electronic agency.¹⁴

1.1.2 Types of Electronic Agents and Their Preparation

A. The jurisprudential and technical concept of blockchain technology

Blockchain technology is considered one of the most prominent contemporary technological innovations. It initially emerged as the technical foundation for virtual currencies, but it quickly evolved into an independent technology in its own right, and today it is regarded as one of the pillars of the modern digital revolution.

Among the doctrinal definitions presented, Professor Michael Crosby defined it as: "A distributed database of records, or a public ledger of digital transactions or events that have been executed and shared among participating parties. Each transaction in the public ledger is verified by the consensus of a majority of participants in the system, and once the information is recorded, it cannot be erased."¹⁵

Others have defined it as: "A digital list of records in which transactions are recorded in 'blocks' that are linked through cryptography. Once the blocks are filled with data, they are time-stamped chronologically and added to the blockchain in a manner that is verifiable and cannot be altered without the consensus of the majority of participants".¹⁶

Professor Aaron Wright views blockchain technology as a chronological database of transactions recorded by a network of computers. Meanwhile, Garrick Hileman and Michel Rauchs consider blockchain a form of Distributed Ledger Technology (DLT), consisting of a series of cryptographically linked blocks containing aggregated transactions, with all data publicly disseminated to all participants in the network.

It is also described as the data records created upon the execution of each digital transaction—such as a virtual purchase or an electronic vote. Instead of being stored in a single location, like paper records or digital archives, this data is simultaneously distributed across thousands of computers through what is known as a peer-to-peer (P2P) network. This network employs algorithms to verify transactions; each valid block is timestamped, appended to every copy, and integrated into the evolving “chain of blocks.”¹⁷

Meanwhile, Satoshi Nakamoto introduced it in a programming research paper entitled “Bitcoin: A Peer-to-Peer Electronic Cash System,” where he described it as an electronic ledger system used in commercial transactions¹⁸. This system is distinguished by its ability to record transactions not on a single computer, but across a large number of computers in a decentralized network. All records are publicly available and can be accessed at any time free of charge; therefore, hacking or altering these records is no longer possible.¹⁹

Accordingly, blockchain technology represents the digital platform through which smart ²⁰contracts are executed and completed, as it serves as an electronic ledger that contains all the data related to the contracts. It is encrypted, secure, and highly resistant to manipulation or alteration.²¹

B. The Legislative Concept of Blockchain Technology

It is observed that the U.S. legislator, specifically the State of Illinois, addressed the concept and parameters of blockchain technology in many instances. Moreover, it went further by enacting a dedicated law, known as the *Blockchain Technology Act (BTA)*,

which entered into force on January 1, 2020. In this Act, blockchain technology is defined as: (205 ILCS 730/5): “ "Blockchain" means an electronic record²² created by the use of a decentralized method by multiple parties to verify and store a digital record of transactions which is secured by the use of a cryptographic hash²³ of previous transaction information” .²⁴

It is meant by this that it is an electronic ledger created through a decentralized method by multiple parties in order to verify and store a digital record of transactions, and this ledger is secured using a cryptographic hash function.

As for the Washington State Law of 2019 (SB 5638), it defined blockchain technology as: “Blockchain’ means a cryptographically secured, chronological, and decentralized consensus ledger or consensus database maintained via the internet, peer-to-peer network, or other similar interaction.”

And by this it means that it is an encrypted, secure, chronological, and decentralized ledger built on consensus, or a consensus-based database maintained via the Internet, a peer-to-peer (P2P) network, or any other similar means of communication.²⁵

C. Characteristics of Blockchain Technology

Blockchain technology plays an extremely important role in all areas of life, as it has come to permeate all sectors, thereby bringing about a genuine leap, particularly in the world of the digital economy. This is a result of the technical features it possesses, since blockchain technology is a decentralized ledger (first), open (second), distributed (third), based on consensus (fourth), and on peer-to-peer technology (fifth), in addition to being immutable and tamper-resistant (sixth), as well as chronologically ordered (seventh), and finally transparent (eighth).

Decentralized Ledger

The Blockchain Institute in France defines this technology as: “A technology for storing and transferring information, transparent, secure, and operating without a central control authority”.

It is noted that this definition includes a unique feature of this emerging technology, namely the ability to transfer information or assets without a central supervisory authority. In this respect, it surpasses other similar systems, being regarded as one of the disruptive technologies.²⁶

The feature of a Decentralized Ledger means that it allows the exchange of any type of transactions between two parties without the need for a central authority to regulate these transactions. In other words, there is no single central entity where all data and information are stored and controlled, as is the case in Centralized Systems, which are managed by one central authority.

The clearest example of this is when a group of individuals open an account with a bank or financial institution and deposit a certain amount of money: they cannot directly carry out any operation or transaction on those funds except through the system of the bank or the financial institution where the money was deposited²⁷. The same applies to traditional intermediaries who authenticate or record transactions between contracting parties, such as land registries for property records, brokers in sales and rental operations, or notaries in contract authentication, etc.

By contrast, Blockchain technology provides a mechanism where a copy of the data is stored with all participants in the network, and management is based on consensus among them all.²⁸

Open Ledger:

This is what the scholar Jean Paul Delahaye described as: “A huge ledger that everyone can read freely and for free, and everyone can write on, but it is impossible to erase and indestructible.”²⁹ This is because it is essentially a database in which all contractual

transactions are recorded in the form of long, encrypted, and secure linear chains distributed across millions of computers belonging to participants around the world. All financial transactions and operations are inscribed on it, thus achieving significant benefits for the various parties dealing with it.

Distributed Ledger:

Since Blockchain technology is always an open ledger to the public, it allows all users of this technology to access it at any time and from any place, given that the entire chain is publicly distributed across numerous points on the network called Nodes. This means that there is a copy of the Blockchain network's data with all members, and any modification or operation that occurs on the network is added synchronously to all members of the Blockchain network.³⁰

Consensus-Based Ledger:

What is meant by this is that Blockchain technology operates on the principle of consensus in decision-making within the network. There is no specific centralized authority entrusted with making decisions inside the Blockchain network. Consensus in decision-making is achieved through network members following certain consensus protocols. These protocols consist of specific rules, provisions, and regulations used to manage the network, which are applied whenever a decision needs to be made regarding any change that occurs to the state of the network by its members³¹.

Peer-to-Peer (P2P) Ledger:

Blockchain technology is characterized as a peer-to-peer (P2P) network, meaning that all relevant parties within the network can access this system at any time in order to verify transaction assets, record their data, process them, and reach a state of collective consensus depending on the purpose of the network. Subsequently, all parties confirm the transaction through a process known as mining, and once all parties have reached consensus on the transaction, a new block is created and directly added to the chain of

blocks in the network without the intervention of any central authority to carry this out.

Immutable Ledger:

Blockchain technology enjoys a unique feature that distinguishes it from other systems, namely the hash function³² (also referred to as the hashing mechanism). This consists of algorithms that transform the data entered into a block within the Blockchain network—regardless of its size or type—into a unique set of symbols, numbers, and characters of fixed length known as the hash, which serves as a distinctive fingerprint of the recorded data, much like a human fingerprint.

The high level of security associated with Blockchain technology is directly linked to the hashing technique, since each block in the chain contains its own hash. In other words, every block in the chain also stores the hash of the previous block, which means that Blockchain is a chain of blocks interconnected through encryption. If one member attempts to alter the data of a particular block, its hash will inevitably change, and this alteration will be reflected in all subsequent blocks. This implies that if someone wanted to modify the data of a given block, they would have to alter all the blocks that follow it—something that is virtually impossible—because, as previously explained, Blockchain is an open and distributed data ledger³³. This implies that the hashing mechanism prevents any modification—whether by addition or deletion—of the data recorded on any Blockchain chain, thereby ensuring the provision of the service with the highest possible quality.

Chronological Ledger:

Since Blockchain technology consists of a series of blocks that must be sequentially and temporally linked, this means that each block contains a timestamp that records and specifies the exact time it was added to the chain. Naturally, this timestamp cannot be altered or tampered with, given the cryptographic features inherent in Blockchain technology³⁴.

-Transparent Ledger:

Transparency is considered one of the most important outcomes of decentralization in Blockchain technology. It provides all network participants with the opportunity to verify the accuracy of data, information, and supporting documents in real time as soon as they are placed on the network. As explained earlier, Blockchain operates as a distributed and open ledger of which every member has a copy. This demonstrates that Blockchain is a secure digital technology characterized by credibility and transparency.³⁵

1.2 Types of electronic agents and how to set them up

A. Types of Intelligent Agents

There are various types of intelligent agents that differ according to the purpose of the electronic agent, and below we present the most important of these types:

-Reactive Agent

The reactive agent is considered one of the simplest types of intelligent agents, as it relies on direct responses to inputs without possessing memory or a prior database. Its role is limited to processing real-time signals or instructions and interacting with them immediately, without any accumulation of knowledge that would allow it to benefit from past experiences. In the legal context, this type of agent is used in simple electronic contracts, such as automated responses to purchase requests on commercial websites or providing consumers with instant information.

From the perspective of electronic transactions law, the reactive agent raises an issue related to its limited ability to adapt to changing contractual circumstances, which poses questions about its validity as an alternative to the traditional agent in contracts of a continuous nature. Its mechanical response may result in shortcomings in recognizing the essential considerations required by certain contracts, which calls for legislative intervention to establish safeguards

ensuring the protection of parties from any negative consequences arising from the limitations of this type of agent.

-Limited Memory Agent

The limited memory agent is considered more advanced than the former, as it can store temporary data that is later used in the decision-making process. This enables it to respond more accurately to variables, particularly in contracts that require consideration of past circumstances or ongoing data, such as self-driving transportation contracts or digital logistics services. In this case, the agent demonstrates a certain degree of "memory," even if temporary, which allows it to rationalize its decisions.³⁶

Legally, this type of agent raises the issue of defining the scope of liability in the event of an error in interpreting stored data, as the temporary nature of storage may lead to the loss or neglect of information that affects the obligations of the parties. It is possible that the matter of the intelligent agent's "informational negligence" could be brought before courts or arbitration bodies, and its impact on the validity of electronic consent may be questioned. This imposes on the legislator the necessity of setting standards of accuracy and transparency in the operation of this category of agents.

-Knowledge-based Agent

The knowledge-based agent is built on a broad database and an inferential system that enables it to make complex logical decisions. The presence of an integrated knowledge base grants it the ability to analyze facts and alternatives, making it suitable for dealing with contracts of a complex nature, such as electronic financing contracts or international commercial transactions through digital platforms.

From a legal standpoint, this type is considered the closest to the idea of the traditional agent, since it acts based on specific "knowledge," even if programmatic. However, the problem lies in the extent to which "legal intent" can be attributed to it, especially in cases where it concludes contracts on behalf of human parties. Here, the debate arises as to whether the availability of a knowledge base

is, in essence, equivalent to the availability of contractual intent, a matter that calls for reconsideration of certain traditional concepts of consent and agency within the digital environment.³⁷

-Adaptive Agent

The adaptive agent represents a qualitative leap in artificial intelligence, as it demonstrates the ability to continuously learn from its environment and adjust its behavior according to changing circumstances. This type is widely used in digital financial markets that require dynamic decision-making, such as predicting stock prices or determining suitable offers for consumers based on their behavioral patterns.

Legally a highly significant challenge arises regarding the legitimacy of the “evolving decision” made by the agent after learning, since its new behavior may differ from what was originally programmed. This raises the issue of the extent of liability borne by the programmer or the principal for the agent’s actions, particularly if these actions go beyond reasonable prior expectations. Hence, there is an urgent need for specific legislation to regulate this type of agent and establish clear standards for its legal responsibility toward third parties.³⁸

-Collaborative Agent

The collaborative agent operates within a network of agents, whether human or electronic, and relies on information exchange and coordination to make collective decisions. This type forms the basis of Multi-Agent Systems, which are used in international trade, where several agents integrate to conclude complex contracts that simultaneously cover transport, insurance, and payment.

In the legal context, the collaborative agent raises the issue of determining liability in the event of a collective error, as the decisions of several agents may overlap simultaneously, complicating the identification of the party obliged to provide compensation. This also opens the door to discussing the principle of “shared liability” in the digital environment, which may require the establishment of new

rules inspired by theories of collective responsibility in traditional law and adapted to the electronic world.

-Autonomous Agent

The autonomous agent is the most advanced among all types, as it enjoys a high degree of independence and the ability to make complex decisions without human intervention. This type represents the core of Smart Contracts, which are self-executing once their conditions are met on blockchain platforms.

However, this advancement presents the greatest legal challenge: the issue of recognizing a “legal personality” for the autonomous agent. If it acts completely independently, who bears responsibility for its actions? Is it the programmer, the user, or should the agent itself be granted a distinct legal status similar to that of corporate entities? This question constitutes the center of jurisprudential and legislative debate in contemporary international law and is expected to be one of the most prominent challenges of the twenty-first century in the field of digital law.

-The Electronic Agent for Legal Transactions

From a contractual perspective, the electronic agent can be divided into two main types: the Buyer’s Agent and the Seller’s Agent. Each of these will be addressed in detail below.³⁹

-Agents Representing Buyers

This type of agents is known as shopping agents or buying agents because they are designed to assist buyers in searching for products and services that satisfy their desires. Given the enormous amount of goods and services offered online, many of which are similar, the search and evaluation process becomes burdensome for the electronic consumer. Therefore, this type of agent helps provide advice, guidance, and direction to the consumer toward the best products or services available on the Internet that they wish to acquire.

The importance of buyer agents lies in facilitating contracting for buyers in two main respects. First, the buyer's agent facilitates access to quality products by searching for brand names or product types and creating a list of distributors of such products or services, as well as after-sales services. Second, it provides consumers with information related to the offer, such as prices, services, and past experiences.

-Agents Representing Sellers

Merchants, whether institutions or individuals, can also rely on electronic agents to continuously display goods and services on the Internet without interruption. Given the high volume of consumer requests, which may reach thousands of messages, the seller needs an electronic agent to record the data relating to each consumer's requests and adjust them according to consumer demands each time.

B. Preparing the Smart Agent

The preparation of the smart agent is not limited to a simple programming process, as in the case of the traditional electronic agent. Instead, it requires a more complex approach that integrates artificial intelligence and machine learning technologies with data processing systems. The first step begins with a deliberate human decision taken by the programmer or the legal entity to design a smart agent capable of performing certain tasks. These tasks go beyond pre-set responses to include the ability to adapt to digital environments and deal with unforeseen variables. This decision reflects the shift in responsibility from merely creating an automated program to building a relatively independent knowledge system.

The second step consists of designing the software architecture of the smart agent, whereby the programmer equips it with advanced algorithms based on machine learning techniques and artificial neural networks. Here, programming is not limited to inputting static information; rather, the system is built to learn from data flowing through the Internet or from past experiences. This aspect represents the core difference between an ordinary electronic agent, which

executes fixed commands, and a smart agent, which develops its abilities and reshapes its responses over time.

The third step consists of the “adaptive operation” phase, where the smart agent begins to operate according to the algorithms it was programmed with, while at the same time readjusting its behavior based on acquired experience. It is capable of negotiating, analyzing options, and reprioritizing in line with the principal’s interest—whether in concluding a purchase contract, drafting an offer, or interacting with other agents in a digital environment. This development grants it near-complete autonomy, which distinguishes contracts concluded through it as spontaneous and dynamic.

Finally it should be noted that the smart agent has the feature of “dialogue and interaction” with other parties, whether natural persons or artificial agents, unlike the traditional electronic agent whose role is limited to predefined responses. This enhances its importance in smart contracts based on blockchain technology, where it automatically executes conditions and carries out precise legal operations without the need for direct human intervention. Thus, preparing a smart agent is not merely programming; it represents building a digital persona capable of exercising an authentic legal role in the electronic environment.

1.3 The Legal Characterization of the Intelligent Agent between Electronic Personality and Technical Nature

The smart agent raises a fundamental issue related to its legal characterization: Can it be considered merely an advanced technical tool fully subject to the authority of the human who created it, or does it deserve to be granted some form of electronic personality that allows it to exercise independent legal roles? This issue stems from the dual nature of the smart agent, as it combines being an automated technical program on the one hand and having the ability to make self-directed decisions based on learning and adaptation on the other.

According to the first view, some scholars regard the smart agent as a purely technical tool that does not differ in essence from a

computer or traditional programs, regardless of their level of sophistication. Under this view, the smart agent remains merely a legal extension of the natural or legal person who programmed or uses it, whereby all obligations and legal acts it undertakes fall upon the principal, as the original holder of intent.

On the other hand, another view advocates recognizing the smart agent with a form of limited electronic personality, similar to legal personality, which allows for the attribution of certain rights and obligations to it independently. This perspective is based on the fact that the smart agent's role is not confined to executing fixed instructions but is distinguished by its analytical capacity and independent decision-making in unforeseen contexts. This brings it closer to the notion of a "virtual will," thus making it more than just a tool, especially in the realm of smart contracts and automated financial transactions.

Nevertheless, such recognition of electronic personality remains highly controversial. Opponents argue that granting the smart agent the status of a "person" could create a legal vacuum regarding civil and criminal liability. In law, personality necessarily entails accountability, while it is difficult to conceive of holding an intangible artificial entity fully responsible without ultimately reverting to those behind it—programmers, users, or owners.

Accordingly, it can be said that the legal characterization of the smart agent oscillates between those who regard it as merely a sophisticated technical attribute inseparably linked to humans, and those who see in it the features of an emerging electronic personality requiring new legislative treatment. The solution may lie in creating an intermediate legal system that acknowledges its special capacities without granting it full personality—similar to some systems that have conferred robots with a distinct legal status allowing the regulation of their operation and the control of their legal effects.

2. The Evidentiary Value of Concluding Smart Commercial Contracts and Their Legal Effects, between the Traditional Theory of Contract and Intelligent Mechanisms

2.1 The Extent to Which Traditional Contract Rules Accommodate the Mechanism of Automated Conclusion

Modern technology has witnessed a rapid leap across various fields, in contrast with the evident slowness of legislative systems in establishing legal rules to regulate these transformations. It is observed that most legislations, whether at the Arab or international level, have not yet kept pace with the profound developments brought about by artificial intelligence, despite its becoming a reality that significantly influences all transactions, particularly civil contracts, where intelligent systems have come to play central roles in the processes of conclusion and execution.

In the absence of legislative recognition of artificial intelligence as an independent legal person, the question arises as to the legal nature of the acts carried out by it. Contracting through such systems may be understood from two perspectives: either as contracting through representation, whereby the intelligent system assumes the role of an electronic or “intelligent agent” that expresses the will of the programmer or original user; or as an act carried out in a quasi-independent manner, raising profound debate over the extent to which the will of a non-human entity can be recognized.

When examining the traditional elements of a contract, the subject matter and cause generally do not present significant difficulties in the context of automated contracting, since they are often tied to the lawful object and purpose of the agreement. However, consent remains the primary challenge, as the expression of will here does not emanate directly from a natural person, but from intelligent systems based on complex algorithms pre-programmed to automatically respond to contracting requests. This highlights the importance of distinguishing between the stage of conclusion, where the intelligent agent is presumed to express a will predetermined by the human owner or programmer, and the stage of execution, where the

intelligent agent may exercise a degree of autonomy in decision-making based on the data available to it.

The notion of the intelligent agent offers an intermediate model in the legal characterization of this phenomenon. It is not an independent legal person, but rather an advanced technical tool granted the capacity to express will on behalf of its user. This approach allows contracts concluded through such agents to be subject to the general rules of contract law, while relying on jurisprudential and legislative efforts to address practical gaps, especially concerning the determination of liability and the interpretation of the scope of consent.

Ultimately, the question of whether artificial intelligence systems are capable of contracting remains largely theoretical. If contract conclusion were to occur independently, it would necessitate recognition of legal personality. However, conclusion by representation on behalf of the designer owner⁴⁰, or user of the artificial intelligence does not require such recognition. In this sense, it may be conceivable to apply the general rules governing transactions, such as sale and lease, to artificial intelligence systems.

A- The Conclusion of Smart Contracts through Representation:

Representation in contracting is defined as “the substitution of the will of a person, called the representative, in place of the will of another person, the principal, in creating a legal act whose effects are attributed to the principal and not to the representative.” Although a smart contract, which operates on mathematical algorithms, differs from a traditional contract due to its autonomy and decentralization in operation arising from its automated nature, there is no disagreement regarding the possibility of artificial intelligence algorithms functioning within the framework of representation. In this sense, intelligent systems act just like an ordinary representative, performing legal acts and transactions, thereby assuming the role of an intelligent agent on behalf of the designer or owner⁴¹.

Agency, in its general and traditional sense, is based on the principal's trust in and familiarity with the agent, and is often concluded in the contract session, whether between parties present or absent. However, the evolution of transaction practices and the emergence of intelligent systems have necessitated the creation of practical software that allows the delegation of acts and transactions of network users to such programs, which then interact independently with their surrounding environment to operate in an appropriate and systematic manner.

As a result, the intelligent agent emerged, defined as “a technical machine or intelligent system acting as an agent on behalf of the principal — the designer, owner, or user. The intelligent agent is essentially a program that interacts independently with changes in its environment and performs the tasks assigned to it without direct human intervention.”⁴²

At the international level, it is noted that the UNCITRAL Model Law on Electronic Commerce did not expressly address artificial intelligence programs or electronic agents. Article 13 thereof stipulates, as a general principle, that a natural or legal person must be held responsible for any operation resulting from information programmed by or on their behalf automatically⁴³.

Similarly, the UAE Federal Law No. (1) of 2006 on Electronic Commerce and Transactions defined in Article 1 the “automated electronic intermediary” as “a program or electronic system for an information technology tool that operates automatically and independently, wholly or partially, without supervision by any natural person at the time the operation is carried out or responded to”⁴⁴.

Moreover, Article 12 of the same law permitted “contracts between automated electronic means that include two or more electronic information systems, prepared and pre-programmed to carry out such transactions, to be valid, effective, and producing legal effects even in the absence of personal or direct intervention of any

natural person in the process of concluding the contract within such systems.”⁴⁵

The Algerian legislator, however, did not address the subject of the smart agent or the electronic intermediary in Law No 18-05 on Electronic Commerce⁴⁶. Nevertheless, the general rules of the Civil Code relating to legal representation may be applied to the smart agent operating through automated electronic means, given that there is no need to recognize a legal personality for such technologies; they do not conclude contracts independently, but rather in the name and on behalf of a legal person.⁴⁷

B- Problems of AI contracts at the conclusion stage.

At the conclusion stage, AI contracts raise a number of legal problems primarily related to the element of consent, as the cornerstone of contract formation. The central question is: Can it be said that AI systems possess a "will" in the legal sense that makes their expression of acceptance or offer valid and binding? This question becomes more complex when linked to the conditions of sound legal capacity and formality in smart contracts, especially given the lack of recognition of an independent legal status for the electronic person or the smart agent.

- The issue of subject matter and cause in smart contracts

Theoretically, subject matter and cause do not pose significant difficulties. It is sufficient that the subject matter of the contract be legitimate and that a valid legal purpose be present for the obligation to be valid. However, the real problem lies in the element of consent. In traditional contracts, consent is understood through an explicit or implicit exchange of offer and acceptance between two human parties. In contracts concluded through artificial intelligence systems, however, the expression of will is accomplished through algorithms and software that may be pre-configured by the programmer or owner. This raises the question of the true nature of this will: Is it the inherent will of the system, or a derivative will legally attributed to the human who designed or activated it?

To answer this question, a distinction can be made between the following types of contracts:

- Free bargaining contracts: These are contracts based on direct negotiation between the parties to reach a mutually satisfactory formula. This differs depending on the level of development of the intelligent system:

With respect to narrow-scope artificial intelligence, its capabilities are limited to pre-defined tasks, which places it in the position of an "intelligent agent" that carries out the orders of its designer or owner without the freedom to negotiate or rewrite the terms. Consequently, its consent cannot be relied upon as a true, independent will.

As for general-purpose AI, despite its sophistication and ability to perform complex simulations, relying on it to conclude bargaining contracts remains risky, especially since it may make decisions whose course cannot be predicted or whose rationale cannot be understood, which undermines confidence in considering its consent as a complete legal expression. Regarding super-intelligent AI, although talk of it remains hypothetical for now, it is expected to be capable of engaging in real negotiations and perhaps even issuing objective judgments that exceed human capabilities. In this case, jurisprudence raises a fundamental question about whether it should be granted independent legal personality or whether it should be treated as an intelligent agent with expanded powers.

- Contracts based on programmed acquiescence or acceptance: In this case, the contract is concluded based on pre-determined data and conditions, and the role of the intelligent system is limited to implementing the programmed instructions. Here, the role of the intelligent agent is clear, as it is merely a technical tool that expresses the will of its original user, without possessing an independent personality or its own will.

Therefore, the fundamental issues of AI contracts at the conclusion stage lie in how will and consent are attributed: Should they be attributed to the intelligent system as an independent actor, or to the

human who created and programmed it? Here, there is an urgent need for legislative intervention to reformulate contract theory in light of the emergence of the smart agent, so as to regulate the scope of their legal liability and clarify the limits of their powers to express their will, ensuring the stability of transactions and protecting contracting parties.

- The Issue of Capacity in Smart Contracts⁴⁸

Capacity is an essential condition for the validity of contracts under traditional rules, as consent issued by a person lacking or diminishing legal capacity is not accepted. However, verifying the availability of legal capacity poses an extremely complex issue within the scope of smart contracts. This is because transactions take place in a virtual environment, which in most cases does not allow for verification of the contracting party's age or legal status. Even with the existence of monitoring and verification programs, the possibility of fraud remains through advanced software that enables minors or those lacking legal capacity to open and transact through accounts.⁴⁹

The situation becomes more complex when resorting to smart agent systems, as the automated system may undertake negotiations or offer and acceptance on behalf of a person who lacks legal capacity, raising questions about the validity of the contract. Furthermore, the prevalence of transactions under pseudonyms or virtual identities makes verifying the identity of the other party a nearly impossible task. This opens the door to error regarding the identity or legal capacity of the contracting party, especially in the absence of adequate technical and legal mechanisms to examine this issue. This demonstrates the inadequacy of traditional rules in addressing this phenomenon, necessitating the development of legislative and technical solutions that ensure the control of legal capacity in the digital environment.

- Formalism in AI Contracts

AI contracts are often based on blockchain technologies, where the contract is automatically concluded between parties who do not share a common contracting body and often do not know each other personally. This represents a departure from the traditional concept of a contract, which is based on a clear meeting of two wills at a specific time and place. It is noteworthy that most of these contracts lack traditional formality. They do not require writing or specific wording. Rather, obligations are translated into software codes that automatically determine how they are to be implemented. However, the lack of clear written wording makes it difficult for parties to precisely define terms and obligations, or even refer to them in the event of a dispute. This may undermine transparency and weaken the protection of the weaker party.

In this context, the smart agent presents a new concept of formality. It acts as a technical tool that regulates the conclusion and implementation process based on prior programming, giving the contract an "electronic" form as an alternative to the written form. However, this alternative form still requires clear legislative recognition that defines its evidential value and ensures the possibility of monitoring contractual terms.

2.2 Problems with AI contracts during implementation.

While a smart contract, like a traditional contract, creates legal effects once it is properly formed with its elements and conditions in place, the implementation phase poses particular challenges related to the ability to interpret the contract, on the one hand, and the possibility of amending or canceling it, on the other. This is due to the technical nature of the smart contract, which is not based on traditional drafting, but rather on programming instructions executed automatically using blockchain technology or via the mediation of a smart agent.

A- Smart Contract Interpretation

The established principle in traditional rules is that contract interpretation aims to reveal the common will of the contracting parties. The legislator has obligated judges not to deviate from the clear provisions of the contract, as stipulated in Article 111/1 of the Algerian Civil Code: "If the wording of the contract is clear, it is not permissible to deviate from it by interpreting it to determine the will of the contracting parties." However, this principle clashes with the nature of the texts themselves in smart contracts, as they are not written in natural language, but rather in complex programming language such as Solidity, which only technology experts can understand. This leaves the common will of the parties hidden behind the programming code, making it difficult for the judiciary to verify it or discern its intent. The problem becomes more complex when a smart contract relies on external sources of information (oracles) for its execution, such as contracts linked to stock market prices or weather data. If these sources are disrupted or provide the contract with incorrect information, automated execution may deviate from the original intent of the contracting parties. This is where the role of the intelligent agent emerges as an intermediary between the software system and external reality. It can be programmed to verify the reliability of the sources or to activate a preventative control mechanism. However, the question remains about the validity of an interpretation issued by an "intelligent agent" that does not have an independent legal personality.⁵⁰

B- The impossibility of amending or reviewing a smart contract

General rules stipulate the possibility of reviewing or amending a contract by agreement of the parties, or even revoking it in certain cases, in accordance with the principle of "the contract is the law of the contracting parties." In fact, the legislator has authorized the intervention of a judge to amend obligations when fundamental circumstances change (Article 107/3 of the Algerian Civil Code). However, this flexibility clashes with the specificity of smart

contracts, as their provisions are recorded on the blockchain network and automatically executed when the conditions are met, making them fixed and irrevocable after they are established.

A smart contract is programmed with the concept of "irrevocability." That is, transactions cannot be canceled once their conditions are met, without taking into account any subsequent exceptional circumstances. Jurist Christoph Müller points out that "the computer cannot incorporate undefined legal concepts and take into account defects in agreement or any future change in circumstances." For example, if a flight ban results in a longer flight, a smart contract pre-programmed to execute payment upon booking will remain in effect without modification, unless it includes a special condition allowing for review. In this case, the aggrieved party has no choice but to resort to civil court to demand the reimbursement of what they paid.

The problem increases when the contract is concluded through a smart agent that automatically executes obligations. If exceptional circumstances arise that were not anticipated by the programmer, the smart agent lacks the discretion to amend the contract, but remains bound by coded commands. This places the legal system in a dilemma of reconciling the strictness of automated contract execution with the flexibility of general rules that allow for review of obligations.⁵¹

2.3 Legal Challenges Related to the Evidentiary Value of Contracts Concluded through the Intelligent Agent

Under artificial intelligence, contracting is no longer merely a traditional process between two natural or legal persons. Rather, it is now conducted through advanced technological means, most notably the smart agent. This agent is not an independent legal person, but rather a software system or automated system pre-programmed to express the will of the owner or user, or to make automatic decisions within certain limits. However, resorting to this new type of contracting raises legal challenges that affect the validity of contracts

concluded through it, whether from the perspective of proof, legal liability, or legislative recognition.

A - The Problem of Legal Recognition of the Smart Agent

The smart agent raises a central issue related to the legal system's recognition of it as an intermediary in concluding contracts. Traditional rules require the presence of two parties with full legal capacity to exchange offer and acceptance. However, the smart agent is neither a natural nor a legal person, but rather an automated software system. This raises the question: Is its action an expression of a legal will in its own right, or merely an extension of the will of the owner or programmer?

Most jurisprudence holds that the will attributed to a smart agent is essentially the will of the owner or user who activated it, just like any traditional agent. However, what distinguishes a smart agent is the degree of independence it enjoys, as it may conclude or implement a contract according to algorithms that exceed the original expectations of the owner. This partial independence makes its legal recognition a complex issue, oscillating between describing it as a mere technical tool and viewing it as a potential future legal actor.

In light of this situation, legal recognition of smart agents remains absent from most legislation, creating a regulatory vacuum that deepens the problem. The absence of explicit texts leads to uncertainty about the validity of contracts concluded by them, and makes resorting to general rules merely a temporary solution that falls short of the practical challenges posed by artificial intelligence technologies in the field of contracting.⁵²

B- The Validity of Evidence in Smart Contracts

General rules require that a contract be provable before a court. This raises a particular problem with contracts concluded by a smart agent. These contracts are often documented in the form of software codes stored on blockchain networks, technical records that are not easily translated into clear legal terms. Consequently, the validity of

these contracts remains a subject of jurisprudential and judicial debate.

Although modern legislation, including Algerian legislation, has recognized electronic documents as equivalent to traditional writing, this validity is insufficient to address the special nature of a smart contract. The programming language in which this contract is written requires advanced technical expertise to read and understand its intent, a capability that judges or litigants may be unable to master. This weakens the guarantees of proof and makes the contract's validity dependent on the expertise of third parties. Therefore, the validity of contracts concluded through smart agents remains relative, closer to presumptive force than to full evidence. This necessitates legislative intervention to frame the evidential value of smart contracts by establishing common technical and legal standards, ensuring a balance between the reliability of the technology and the requirements of judicial justice.⁵³

C- Challenges of Contractual Liability

Liability is one of the most complex challenges facing contracts concluded through smart agents. If the latter fails to implement the contract or a glitch occurs in its software system, the question arises as to who is responsible: Is it the owner, as the principal in the contract, the programmer who designed the algorithms, or the provider of the technical platform through which the contract was concluded?

In the absence of explicit texts, jurisprudence typically assigns liability to the human party that used the smart agent, based on the idea that the agent is merely a tool. However, this approach does not address the issues arising from the smart agent's independence and its ability to make decisions unforeseen by the user. Furthermore, placing full responsibility on the programmer or platform provider may seem unfair, given the complexity of the smart contract environment and the multiplicity of actors within it.⁵⁴

Therefore, determining liability in contracts concluded by smart agents requires a reformulation of the traditional rules of contractual liability. This can only be achieved through specific legislation that takes into account the specificity of the digital environment and clearly defines the position and role of each party in the contractual process. This ensures that the validity of these contracts does not remain a mere theory incapable of practical application.⁵⁵

D- The extent to which smart contracts are compatible with mandatory rules.

Traditional contract rules are not merely supplementary rules; they contain mandatory rules related to public order, such as the legality of the subject matter, consumer protection, and ensuring transparency. However, the smart agent, as a technological tool, cannot distinguish between legitimate and illegitimate contracts. Instead, it automatically executes the commands programmed for it. This may lead to the conclusion of contracts that violate public order or are harmful to the weaker party, weakening their validity and making them vulnerable to nullity or absolute invalidity.⁵⁶

E. Deficiencies in legislative regulation.

Although jurisprudence and the judiciary have begun to discuss the legal status of smart contracts, most Arab legislation—including Algerian legislation—has yet to establish specific provisions regulating smart agents. This legislative vacuum leaves contracts concluded by the latter in a state of ambiguity, as their validity can only be determined by reference to general rules, which were originally established to regulate traditional contracts between humans.⁵⁷

3. CONCLUSION

This study highlights that accelerating digital transformations, led by smart agent technology and blockchain-based smart commercial contracts, pose profound legal challenges that go beyond the confines of traditional contract theory. The transition from direct human will to programmed will through artificial intelligence algorithms requires

a reconsideration of the fundamental concepts of obligation theory, particularly consent, capacity, formality, and contractual validity.

The debate over the legal nature of smart agents also revealed a clear legislative vacuum. Most legislation has not yet determined whether to grant them the status of "electronic legal personality" or merely to consider them a technical tool subservient to their programmer or user. This ambiguity has created practical problems in determining liability, ensuring the protection of clients, and preserving the stability of commercial transactions in the digital environment. By examining traditional rules, it can be said that they are partially capable of accommodating some forms of automated conclusion. However, they remain incapable of fully encompassing smart transactions, which are characterized by speed, independence, and difficulty of reversal or modification. Hence, the urgent need to establish a comprehensive legal framework that balances the requirements of legal security with openness to technological innovation.

Results :

- Algerian legislators did not address the issue of smart agents or electronic intermediaries in Law No. 18-05 on e-commerce. However, the general rules contained in the Civil Code regarding legal representation can be applied to smart agents acting through automated electronic media, given the lack of a requirement to recognize the legal personality of these technologies. Because contracts are not concluded independently, but rather in the name and on behalf of a legal entity.

- Despite the advantages of smart contracts, including speed, accuracy, and security, they are not without their drawbacks, as previously mentioned. At the conclusion stage, we encounter the issue of consent and the extent to which an AI robot can express its will, as well as the issue of verifying the identity of the parties, in addition to the formality. At the implementation stage, we encounter the issue of a judge's ability to interpret a smart contract, in addition

to the difficulty of reviewing or even amending it if circumstances change.

- Despite the diversity and differences in legal definitions of a smart contract, it is generally agreed that a smart contract is a self-executing contract executed through a set of programs and algorithms using a technological means called blockchain.

- The absence of explicit legislative regulation of a smart agent raises a problem in determining its legal nature.

- Traditional contract rules are capable of accommodating some forms of automated contracting, but they are insufficient to address the specificities of smart contracts.

- The element of consent remains the most controversial element in contracts concluded through smart agents.

- The issue of legal capacity and formality in smart contracts poses practical difficulties in verifying the validity of the contract.

- The automated execution of smart contracts may sometimes conflict with mandatory rules and the principle of the sovereignty of the will.

- The problem of interpreting smart contracts exists due to the difference between programming languages and natural legal language.

- The inability of smart contracts to be amended or revoked weakens the flexibility of the traditional contractual system.

- The challenges associated with legal liability remain unresolved, especially when an error occurs by the smart agent.

- The technological environment (blockchain), despite its security and transparency, does not address all legal dimensions.

- The continuing gap between rapid technological development and slow legislation threatens the legal security of transactions.

Suggestions:

- Enact specific legislation clearly regulating smart contracts and smart agents,
- Adopt the concept of "limited electronic personality" for smart agents to facilitate the assignment of liability,
- Establish mechanisms to verify the eligibility and digital identity of contracting parties,
- Integrate consumer protection rules into smart contracts,
- Establish legal monitoring platforms (legal oracles) to ensure that contracts do not violate mandatory rules,
- Provide judges with technical tools to understand and interpret smart contracts,
- Develop technical mechanisms that allow for the possibility of amending or revising smart contracts in emergency circumstances,
- Strengthen international cooperation to establish unified rules for smart contracts,
- Intensify legal training and education on artificial intelligence and blockchain technology,
- Encourage multidisciplinary academic research (law, technology, economics) to keep pace with this development.

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22 "Electronic record" means a record created, generated, sent, communicated, received, or stored by electronic means, including a blockchain or a smart contract.

23 "Cryptographic hash" means a mathematical algorithm which performs a one-way conversion of input data into output data of a specified size to verify the integrity of the data.

"Electronic" means relating to technology having electrical, digital, magnetic, wireless, optical, electromagnetic, or similar capabilities.

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