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# Harmonizing Contract Theory with Blockchain-Enabled Smart Contracts

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**Abstract:**

The impact of digital transformation within the legal domain has extended to the theory of contract. This evolution has altered traditional contracting patterns towards electronic contracts and, ultimately, to smart contracts integrated into blockchain technology.

These modern mechanisms, built on the foundations of automation and autonomy, have been effective in accelerating contractual transactions. However, these advantages have created challenges in view of their incompatibility with some of the established principles of contract theory. Therefore, this necessitates a legislative intervention to establish a comprehensive legal framework that ensures the compatibility of this technique, safeguards the safety of its use, and provides the necessary protection for its underlying data attaining contractual security.

**Keywords:** Contract theory; Blockchain; Smart Contracts; Automation; Contractual Security.

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## INTRODUCTION

People's nature has always revolved around transactional freedom; whether they are individuals or groups of individuals organized in entities; they inherently strive to be resilient in whatever they do. In business as in life, they try to be fast, first, and optimal in pursuit of value, while in most cases they perceive essential norms of transactional behaviors (would it be societal or economical) as burdens hampering the achievement of their goals.

In this context, contemporary technology has gifted individuals with capabilities previously unimaginable. This progress results from enhanced methodologies for harnessing knowledge and resources. With the support of the internet, individuals have transcended geographical and jurisdictional barriers and even reduced the importance of the human modus operandi in contractual behavior with an attempt to replace trusted mediums with a number of non-readable encrypted algorithms in the interest of modern needs of the contracting parties that are based on speed in obtaining electronic products and services, gaining time and effort, reducing costs and improving transactional efficiencies.

The concept of "smart contracts" is effectively embodied in computer programs that are inscribed onto blockchain networks. These programs are specifically designed to automatically execute agreed-upon provisions, functioning either as a complement to traditional contracts or as the sole manifestation of an agreement between parties. The same code is replicated and executed across multiple computers (nodes) within the blockchain, thereby utilizing the immutability and security afforded by the network.

Smart contracts are a convenient tool for managing contracts with simple and clearly defined terms. They also simplify the management of a large number of similar individual transactions or a chain of sequential obligations that arise from specific agreed upon events in time. Conversely, and as of today, they remain inadequate for handling more nuanced terms that are either open to interpretation in their nature or cannot be easily coded due to their complexity.

Thus, smart contracts are still nascent, or even embryonic, sort of speak, yet they have gained great popularity with their recognition in several countries such as the United States, France, and the United Arab Emirates, although they are still alien to many jurisdictions, including Arab ones, such as Algeria and Egypt. Considering the perspective that the use of smart contracts and blockchain technology in contractual arrangements, which rely on algorithmic codes not easily understood by everyone, raises concerns, and their nimbleness does not align well with the legal texts established in contract theory, potentially conflicting with some of its fundamental principles. As much as its execution mechanism, to the extent that it provides advantages in speeding up contracts and reducing costs, it may lead to disputes and severe penalties.

Still, the challenges posed by smart contracts do not diminish their importance, and it has become necessary to align them with some of the fundamental principles of contract theory, create a legal framework to accommodate them, and fill the legislative void in the legal systems in response to the aspiring needs of the contracting parties to open opportunities and capitalize on the products of the digital environment that have swept the contractual field. In the context of contemporary technological advancements aligned with scientific progress, there is a significant potential to efficiently leverage the concept of contractual security.

With this in mind, we formulated the following questions: To what extent do smart contracts affect the general theory of traditional contracts? To what extent can these principles be assimilated? And can contract theory be adapted to smart contracts? To answer this problematic, we employed the descriptive method to identify some of the concepts pertaining to smart contracts and all what connects to them and the most important principles in contract theory, as well as the analytical method to examine the functions of smart contracts and explore what results from their use as an emerging technique via the blockchain network with the aim of underscoring their importance at the present time and seeking analogies with traditional contracts for them to be able to fulfill their legal roles and lead the contractual path to its desired goals, in addition to the comparative approach to identify the relevant regulations applicable to this technique to capitalize on the

experiences of some compared legislation that can be identified and taken as a model to bridge the legislative gap that exists between some international and Arab legal systems and the imperatives of the modern world.

The central hypothesis suggests that smart contracts are formulated and executed on a blockchain network that functions according to the principles of blockchain technology within the IoT ecosystem. This allows contracting parties to share their transactions with some applications defined by technical procedures and to recognize with certainty new contracting mechanisms that did not previously exist within the scope of contract theory, giving them irrefutable privacy against the legislative vacuum, which opens the path to the development of an inclusive digital economy. We will then take a look at the future challenges and opportunities for contracting under this disruptive technology.

As we progress, we will aim to achieve the following main objectives:

1- Highlighting the impact of modern smart contracts and their correlation with contract theory by determining the nature of smart contracts and their connection to blockchain technology, their components, their legal nature, their working mechanism, and the issues associated with them;

2- Learning the benefits provided by smart contracts concluded with blockchain technology that stimulates the materialization of their adoption at the local, regional and international levels;

3- Discerning the stakes of enacting smart contracts at the prospect of aligning with the theory of contract and the challenges it faces as it noticeably conflicts with the current contract fundamentals, which calls for legislative treatment to keep pace with modern technological developments.

This study was structured into two primary chapters. The first one focuses on the unique aspects of establishing smart contracts integrated with blockchain technology. The second chapter examines the execution of smart contracts within the contract theory framework.

## Chapter I*:* The Peculiarity of Establishing a Smart Contract Embedded in Blockchain Technology:

The blockchain system is the catalyst that contributed to the emergence and spontaneous development of smart contracts (First

Requirement), which confers on their concept and mechanism of action a specificity that can be attributed to this technology in its digital environment (Second Requirement).

## First requirement: The Role of Blockchain Technology in the Deployment of Smart Contract Services:

Smart contracts are intrinsically associated with blockchain technology, as this platform encapsulates their terms and conditions (First Section) and facilitates the automation of their contractual path (Second Section).

### First section: Blockchain's Contribution to the Implementation of Smart Contracts:

Smart contracts are concluded on blockchain networks with extreme precision, so they are traded according to specific protocols and a digital platform without going through the contractual stages of traditional contracts, such as negotiation, acceptance, and tax payments…etc., as follows:

*First- Blockchain Technology as a Pillar of The Smart Contract:*

The emergence of blockchain technology and the adoption of its applications in some countries has prompted scholars and technology leaders to research its nature, and some defined it as: "A blockchain is essentially a distributed database of records, or public ledger of all transactions or digital events that have been executed and shared among participating parties. Each transaction in the public ledger is verified by consensus of a majority of the participants in the system. Once entered, information can never be erased. The blockchain contains a certain and verifiable record of every single transaction ever made."[1].

The increasing acceptance of smart contracts by recent comparative legislation has been notable in the United States. In June 2016, the governor of Vermont recognized the legality of dealing with commercial documents embedded in blockchain, reinforced by act relating to blockchain business development[2], followed by a law issued in March 2017, in which the State of Arizona recognized the legality of dealing with blockchain in its law[3]. On June 5, 2017, the Nevada County bill was approved, recognizing smart contracts, registrations, and signatures stored in the blockchain, their validity for evidence in accordance with the Federal Electronic Transactions Act, and

eliminated fees as well as the need for a license to be obtained for this purpose. Smart contracts can, as such, be concluded freely in a blockchain platform[4], then other states such as Hawaii[5], Tennessee[6]and Illinois[7] followed suit.

Further recognition of the admissibility of blockchain has been illustrated in France by a legislative text issued in 2017 amending a number of dispositions in the Code of Commerce and the Financial and Monetary Code to establish a suitable legal structure for the transfer of ownership of financial securities[8].

This is consistent with the UAE legislation adopted under Federal Law No. (46) of 2021 on Electronic Transactions and Trust Services where Article 11 stipulated in its first and second paragraphs that: "1. A contract may be made between Automated Electronic Mediums that include one or more Electronic Information Systems that are prepared and programmed in advance for this purpose. Such contract shall be valid, enforceable and legally effective even in the absence of personal or direct interference by any natural person in the process of making the contract in these systems.2. A contract may be made between an automated Electronic Information System in the possession of a particular person and another person if the latter knows, or is supposed to know, that such system will make or execute the contract automatically." Unlike the Algerian, Egyptian, and Saudi legislators, who have not yet explicitly recognized blockchain technology and smart contracts, and where there is an apprehension about their use and the adoption of cryptocurrencies, in anticipation of what will result from their applications in other countries.

*Second - Smart Contracts Integrated into The Blockchain Platform:*

Smart contracts are carried out according to modern digital programming, which adds a kind of doctrinal vacillation around its definition and legal nature, as follows:

1- Definition of smart contracts:

Since smart contracts are newly emerging contracts that are still in the process of experimentation, scholars have not yet agreed on a unified and comprehensive definition for them, due to their diversity and the overlap of technical concepts that they incorporate in the midst of the legislative void regulating them, so they have been called several

names, including “blockchain contracts,” “crypto contracts,” and “self-executing contracts.”

Nick Szabo proposed the concept of a smart contract in 1994, called it in this term and defined it as: “A computerized transaction protocol that executes the terms of a contract”[9], and then redefined it as: “A set of promises, including protocols within which the parties perform on the other promises. The protocols are usually implemented with programs on a computer network, or in other forms of digital electronics, thus these contracts are "smarter" than their paper-based ancestors. No use of artificial intelligence is implied.”[10].

Some define smart contracts “as computer codes that run on the blockchain and include a set of rules under which the parties to that contract have agreed to interact with each other, and when the predefined rules are met, the agreement is automatically executed”[11].

Max Raskin describes the smart contract as “an agreement whose execution is automated” [12]. He asserts that diverse definitions are more suited to the field of computer science, while the critical element for legal considerations is the “excision of human control” referring to a definition of smart contract provided by Christopher D. Clack et al. as being “an agreement whose execution is both automatable and enforceable. Automatable by computer, although some parts may require human input and control. Enforceable by either legal enforcement of rights and obligations or tamper-proof execution”[13].

Building upon the preceding analysis, a smart contract can be defined as an agreement between two or more parties, represented through electronic protocols encoded on a computer or computer network, predominantly utilizing blockchain technology. It operates automatically and autonomously based on preprogrammed conditions or sequences of events, and is enforceable through execution that is impervious to manipulation, while ensuring transparency for all stakeholders regarding all transactions recorded within the blockchain network.

2- The legal nature of smart contracts:

Scholarly perspectives differ in the classification of smart contracts as either genuine contracts or technical instruments that facilitate automation and enhance the efficiency of executing the

original contract. Smart contracts are based on the literal translation of contract clauses and contracting parties' obligations into computer language, which ensures automatic self-execution to avoid execution disputes. However, despite all the views that this "contract's electronic translation" may suggest, smart contracts will not be considered contracts in the legal sense of the term, but only a "copy" of the computerized contractual clauses included in an execution algorithm, that is, a supplement to it.

Thus, it is clear that the smart contract in most cases is only akin to the term contract, because although it produces legal effects, it does not constitute a contract in the legal sense for many, but only with regard to the automatic execution of all or part of the contract clauses.

For instance, French legal scholars have paved the way for smart contracts to be regarded with the same legal standing as traditional contracts, including Claire Leveneur, who proposed approaching and classifying them on the basis of their usage instead of analyzing them from a general standpoint to support their contractual nature[14], while Professors Yves Poullet[15] and Mustapha Mekki[16] went to deny their legal nature, arguing that it is mere technology supporting a previously formed traditional contract.

As for the Anglo-Saxon School, there are some scholars who deny smart contracts the characteristic of "real contract" and consider that they are more like apps, a sort of technology used to safeguard the execution of the classic contract's terms hence eliminating the distinction between the formation and execution stages of the contract[17]; consequently, setting aside the prospect of equivalence or replacement to the contract it in its legal notion. Other studies contend that when the requirements of contract formation are satisfied by smart contracts, they may legally bind the parties depending on the nature of the obligation created by the transaction or the predetermined arrangements the code executes. This applies more specifically to digital services provided and paid for using blockchain technology[18].

Additionally, developers have not been able to digitally transcribe all contracting methods on the blockchain, especially those emanating from the core principles of contract theory, such as rebalancing

opposing contractual obligations and the contract's binding force, among others.

Furthermore, a smart contract (which is a form of a Digital Contract) should not be confused with an Electronic Contract (E-contract), although they seem similar at first sight. While electronic contracts are developed using electronic means and are subject to electronic signatures, they are still written in natural language after the customary contract formation process, executed in the same way as traditional contracts, and subject to a mature legal framework. Unlike smart contracts, which are developed using programming language, not all are governed by the contract formation and execution processes recognized under contract theory.

American legislation, though only at the state level, has been at the forefront of the explicit adoption of smart contracts, granting them the legal stature of a contract in the laws issued by Arizona and Nevada States[19]. Although years later, the European Union issued a more comprehensive legal framework for smart contracts in 2023, which entered into force on January 11, 2024, and will apply from September 12, 2025[20].

It remains that a uniform legal framework at an international level does not currently exist, which may result in certain challenges around the recognition and jurisdictional competence applied to transnationally concluded smart contracts.

Considering the analysis presented, it is evident that smart contracts are distinguished by their digital format, their implementation within the framework of blockchain technology, and their reliance on the language of algorithms in setting contractual terms. They also provide confidence and security to the parties to the contract through the process of automating and encrypting documents, as well as their automatic execution without_third-party intervention, in all safety according to what has been programmed. Despite all doctrinal disagreements on their legal nature and legislative gaps, smart contracts remain adopted by an increasing number of individual and institutional economic agents (e.g. traders, banks, issuers, and exchangers of cryptocurrencies) around the world, producing rights and obligations

and contributing in a certain manner in processing accelerating certain types of contractual transactions.

3- Types of smart contracts:

"Smart contracts combine protocols with user interfaces to formalize and secure relationships over computer networks"[21]. In practice, the contract inherits the features of the network where it is designed, programmed, and executed. Based on this, they can be classified into four types:

a) Smart contracts that are concluded through public blockchain platforms (networks): A public network (Dock, Bitcoin, and Ethereum) is an open-source digital ledger that records transactions in a transparent, secure, and decentralized manner, through which all members of the network can read the data and validate the transactions.

Smart contracts concluded on a public network such as Ethereum can be carried out between anonymous people who own digital wallets and accounts without the platform verifying their actual identities, age, or eligibility to contract, opening the possibility to anyone to create an account or e-wallet and contracting (regardless of whether they are legally incapacitated or incompetent) on any of the public blockchain platforms without the need for verification or permission from any central authority. Then, it is registered on the distributed public ledger often referred to "a secured public ledger with a single source of truth" in coded form, and the account holder or contracting party will not be able to manipulate the smart contract record.

b) Smart contracts that are concluded via private blockchain platforms (networks): while these networks leverage public blockchains and retain all the intrinsic benefits of blockchain technology, access to these platforms is controlled and restricted, and verification of the identity of the parties by the platform operators is an essential requirement and carried out through, among other things, requiring copies of identification documents, completing a Know Your Customer procedure, filling out due diligence forms, and using non-anonymous wallets provided by the platform.

After access is provided, users will appear to other users in the form of encrypted codes called "Blockchain Digital Identity" which institutions and companies rely on through their blockchain platform,

and smart governments are currently adopting their implementation in the delivery of their services.

c) Smart contracts that are concluded via consortium blockchain platforms (networks): This blockchain combines the characteristics of both public and private networks. It operates as an open network, but access to it is restricted to a select group of authorized participants having a direct business relationship or a contractual arrangement that necessitates validation of shared transactions among them, and who have the ability to create and modify contractual transactions. These participants are mostly institutional, such as central banks or consortia of banks, government agencies, commercial organizations, and others. An example of this is Ripple, which allows financial institutions to leverage blockchain technology to complete transactions and transfer funds more efficiently, while also benefiting from its analytical tools and features.

d) Smart contracts that are concluded via hybrid blockchain platforms (networks): Hybrid blockchain combines both private and public blockchain aspects. It allows organizations to deploy a permissioned private system together with a public permissionless system and maintain complete control over who accesses some data stored in the blockchain and what information will be made available to the public. In a hybrid blockchain, transactions and associated records are not publicly disclosed. However, verification is possible when required, such as by granting access through a smart contract. Confidential data is secured within the network, but for verification purposes. Although a hybrid blockchain may be owned by a private entity, the integrity of its transactions remains immutable.

For the purposes of this study, we focus exclusively on smart contracts that are executed via both public and private networks, with the latter representing the predominant type of blockchain technology.

**Second section: Smart Contracts Conclusion Mechanism:**

Smart contracts allow contracting parties to record their rights and obligations and certify and document them on a blockchain platform for paced control and execution while preserving their rights without resorting to a trusteed third party, as will be explained below:

*First- The Participants:* The involvement of participants in "smarting contracting" often depends on the type of smart contract; however, in a general setup, participants in this process are:

a) Contracting Parties: Every person or entity, whether natural or legal, who enters into a contract with another party to establish a specific legal effect, and therefore the smart contract is, in turn, a translation of the terms of the persons involved in protocols with the purpose of formalizing and securing the contracting relationship over a network of computers, and digitally enabling it.

b) The programmer: is a person or entity who, by combining technical skills and computer science, translates the content of the contract into a programming language.

c) Legal Professionals: Legal expertise remains of particular importance in the "setup" of smart contracts, which can be the case for notaries (for instance, in transfer of share-related transactions, drafting the articles of association of a company, etc...) The notary informs the parties and certifies that they recognize the legal consequences of their actions, or a lawyer engaged in a dialogue with the programmer to ensure an accurate translation of the function's (i.e., code and protocol) content.

d) Other Intermediaries: Smart contracts typically require the participation of trusted third parties, including intermediaries who facilitate execution and adjudicators who address disputes related to execution or its absence. Intermediaries may be involved in various stages such as search, negotiation, commitment, and performance. The issue of hidden knowledge, also known as adverse selection, arises before the contract is executed (ex ante), whereas hidden actions, referred to as moral hazards, occur after execution (ex post).[22]

e) Auditor: The role of the auditor is to verify that the newly tokenized smart contract complies with the traditional contract and, more specifically, to ensure that it is programmed in accordance with the will and choice of the parties. The auditor may need to develop several areas of expertise, in particular, must be capable of verifying the program and code structures of the blockchain or smart contract akin to the existing verification processes related to the traditional contract.

e) Oracle: Oracle technology comprises a network of computers specifically designed to gather data on events pertinent to the conditional framework that supports smart contracts, by sourcing information from external environments. This data is subsequently recorded on the platform, providing blockchain participants and operators with insights into real-world events. The integration of this information into the platform facilitates its utilization through smart contracts, thereby enabling automatic execution[23].

*Second- Smart Contracts Lifecycle:*

The strategies and processes utilized in the formulation of smart contracts can differ widely. This variation is contingent upon three distinct factors.

a) the extent to which the execution of the smart contract is automated;
b) the degree of separation between the agreed-upon terms and the code that is executed; and
c) the custodial rights and/or discretion exercised by the parties in relation to the smart contract and its execution[24].

Therefore, we can distinguish the stages of a smart contract from a traditional contract based on some of its features as follows:

1) After completing rounds of discussions and negotiations, the parties involved come to a consensus on the obligations and rights to be incorporated into the contract. Thereafter, notaries, lawyers, or consultants provide assistance to the contracting parties in the formulation of the contractual agreement[25].

2) The process of converting natural languages into programming languages.

This entails developing lines of code that contain instructions for the operation of smart contracts. contractual elements (whether essential or not) are translated into a programming language (Boolean logic). Once inscribed on the blockchain, the smart contract becomes immutable, unless a new version of the code is generated[26].

3) Recording the code onto the blockchain. At this point, the programmer uploads the configured functions, which are then signed by the parties involved, typically using an electronic signature that employs an asymmetric key cryptographic system.

4) The smart contract is integrated within a block, identified by a unique hash code, which contains additional transactions and is permanently and irrevocably added to the blockchain. This process is accompanied by a timestamp that precisely indicates the date and time of the transaction. Consequently, individuals can systematically track, consistently trace, and freely access these transactions[27].

5) When the specified conditions for executing the contract clauses are met, the program triggers and carries out the designated functions by initiating transactions.

6) The smart contract is rendered inactive and stops having any effect. Nevertheless, it remains preserved within the blocks where it was originally recorded, unless the programmer has incorporated, within the instructions, a deactivation function in the code with a designated individual authorized to initiate it.

**Second Requirement: Approaching the Application of Smart Contracts to Some of The Flexible Principles of Contract Theory:**

Smart contracts and blockchain technology raise many questions in their approach to some well-known concepts in Contract Theory (First Section) in an attempt to explore the possibility that these foundational principles governing traditional contracts could permit the creation of a legal framework to accommodate them, beginning with the automated nature of their conclusion process (Second Section).

**First Section: The Applicability of The Elements of Traditional Contracts to Smart Contracts:**

There is no doubt that the elements of traditional contracts are no longer sufficient in their compatibility with the components of smart contracts. If the latter have taken an orientation for their conclusion regarding consent, place, cause, method of proof, and execution, to what extent does this approach stand?

*First- The pillar of consent:*

With reference to the text of Article 59 of the Algerian Civil Code, which considers the pillar of consent to be of great importance in the formulation of contracts in general and regardless of their nature[28]. Smart contracts have created two major issues: the existence of consent and how to express it. How is the offer and acceptance expressed, and what is the required eligibility?

a) Offer and Acceptance: The general rules in traditional contracts require that the invitation to contract includes the conditions of clarity and precision and is associated with the acceptance of the other party during the stage of contract formation[29]. In parallel, the criterion of convergence of wills does not pose any issue, as a smart contract is programmed to automatically execute the data validated by the parties when their conditions are met, which amounts to an implicit expression of the parties' consent. Additionally, the articulated intention, viewed as a unilateral legal act, is inherently linked to both the creation and fulfillment of the contract and serves as one of its crucial elements, despite the absence of direct involvement of the contracting parties in this contractual pattern.

It is worth noting that the completion of a smart contract requires a preliminary stage of shaping and agreeing on the terms of the contract before it is translated into code and transcribed in the blockchain network. Once the contract is published in the network, the parties are bound by the rules of the underlying blockchain. Once the contract is published, the offer cannot be revoked, modified, or altered in any way unless all parties to the network agree to the modification.

Since the acceptance of electronic contracts is not fundamentally different from the acceptance provided for in traditional contracts, which relates to a consensual agreement that is still valid, the difference lies in the fact that it is performed over a network and that the signature is realized through a personal cryptographic key.

Therefore, and according to prevailing transnational regulations, the articulation of an offer and its contractual acceptance can be effectively executed through "data messages" that are systematically recorded within a Blockchain system. These are defined in the United Nations Commission on International Trade Law Model Law on Electronic Commerce (1996) as information generated, sent, received or stored by electronic, optical or “similar” means. This definition seems relevant to both conventional communication methods and digital forms of communication such as smart contracts[30].

Although a blockchain contract is considered a contract between two people present in time, it is considered a contract between two people absent in terms of place due to the different locations of the

offeror and the offeree. Therefore, the rules of contracting between absentees apply to determining where the contract is concluded. This means that the place of conclusion of smart contracts is where the offeror is located at the moment the acceptance is issued, unless otherwise agreed, or there is a contrary legal provision.

b) Capacity: In traditional transactions, the law requires full capacity of the parties, with the will free from any defects, and requires this to be proven; these conditions do not necessarily apply to smart contracts. This is because of the nature of the public blockchain platforms on which smart contracts are based, where the full legal capacity of individuals is not verified. As a result, anyone can create an account without having to prove capacity since there are no eligibility screening mechanisms within smart contracts, allowing the entry of legally ineligible parties.

Consideration should be given to the fact that the issue of capacity does not hinder the completion of smart contracts on private blockchain networks, as blockchain operators proceed to the verification of users' eligibility and ability to act before granting them digital identities. Moreover, blockchain operators can be consulted at any time if needed. Notwithstanding, the impersonation of identity can still be a challenge in private blockchain networks. For instance, individuals may be able to create user accounts while using another person's identity.

*Second- The pillar of The Substance:*

The substance of a contract in smart contracts is subject to the general provisions governing contracts in terms of its existence and identification. The subject matter of a smart contract is often advertised on the network, with a full breakdown of its characteristics and specifications enabling direct access to its components without hindrance. Alternatively, details of the substance can be sent to the contracting party through electronic correspondence.

*Third - The Pillar of Formality:*

The E-writing and e-signature will be addressed, as well as the answer to the question about the possibility of interpreting the phrases of smart contracts?

a) Electronic writing and signature in smart contracts: In order to finalize smart contracts, it is essential to encode their terms, as well as

the rights and obligations of the contracting parties, within the blockchain program and encrypt them to be recorded, stored, copied multiple times and distributed among the nodes of these chains, visible to everyone without the possibility of forgery or modification, and each chain is given an address to which transactions are sent from the users' account, who are able to conclude contracts securely and reliably within a very short period of time and with minimal costs, so that this writing is electronic, not paper-based, and the contract expressions and clauses are written electronically.

When two parties enter into the agreement, the contract will require ratification to become enforceable, with both parties signing it and attesting to its validity and adherence to it. This ratification can be accomplished through various methods, including the utilization of established tools that provide advanced or certified digital signatures or even through the native signature mechanisms available in blockchain technology. These signatures, like digitally signed contracts, have a high degree of authenticity, making them difficult to challenge, except in exceptional cases, such as identity theft. A set of programmed instructions automatically executes the specified terms and conditions without the intervention of a trusted intermediary.

b) Interpretation of smart contract phrases: It is common knowledge that the interpretation of contract phrases, search for the literal meaning within their content, and understanding of the shared intention of the contracting parties is a task entrusted to a mediator, that is, a judge who is mandated to interpret contracts whose wording is either defective, ambiguous, or both, and is restricted to not deviate from the explicit phrases or the intent of the parties when they set the clauses of traditional contracts. However, smart contracts are not subject to this as long as the terms are embedded in a computer code in a technical form that is obscure and may not be comprehended by the judge due to his lack of technical expertise; therefore, he or she may require the services of an expert developer to unlock the smart contract and translate it into natural language based on which he can carry out his task. Additionally, the smart contract cannot contain ambiguous terms and loopholes, as in the traditional contract, to provide the contracting parties with the

necessary latitude to assert that the clause ought to be construed to their advantage.

However, what makes the idea of dispensing with the role of trusted third parties in smart contracts objectionable is that it conflicts with the active pursuit of contract law to consolidate and expand the powers of intervention of the judge who plays a protective role for the contracting parties by determining the content of the contract.

It should be noted that although the governance of smart contracts by a singular interpretation rooted in computer code confers limitations in their flexibility and adaptability, it acts as a universal language that bridges the gap lying under the varied interpretations that can arise from natural languages and facilitates mutual comprehension in contractual relationships[31]. Hence, the adoption of smart contracts, especially in relation to their encrypted components, may minimize court intervention in its interpretation task.

**Second Section: Automating the Smart Contract Process:**

Blockchain has become the right ecosystem for implementing smart contracts and getting participants to place their terms and obligations in a non-modifiable state within programmed ledgers, distributed to everyone in a decentralized platform very quickly and with minimal costs, as follows:

*First- Trust, clear communication and transparency:*

Smart contracts are widely regarded as having the potential to provide complete transparency concerning the specifics of a transaction.

Advocates of smart contracts assert that these mechanisms enhance trust within the contracting process and among contracting parties, particularly during the stages of information and data collection pertinent to the contractual process, as well as in ensuring the certainty of automatic execution of agreed terms. While blockchain technology indeed bolsters contractual reliability, it does not influence the reliability of the contract between the parties, either positively or negatively. This is because the concept of trust between contractors is not relevant at the stage of contract execution; rather, it is more appropriately considered during the contract formation stage[32].

While trust facilitate building contractual relationship, from the legal standpoint under contract theory, the principle of "good faith" remains predominant.

*Second- Speed, shortened timelines and efficiency:*

The formation of conventional contracts is time consuming and involves a series of complex procedures. These procedures begin with prior negotiation and then the actual contracting, with the requirement that the necessary documents must be submitted and sent formally. It requires the presence of two or more contracting parties and the need to exchange their wills, represented by the offer and acceptance, in order to achieve the desired consensus. Subsequently, the final decision is made, with the possibility of withdrawing from the contract if needed.

*Third- Providing security by eliminating the trusted intermediary and reducing costs:*

Immutability and data integrity are two of the most important attributes that give blockchain technology its security feature. This means that all the connected blocks can be examined, making it easier to audit and uncover the subtleties of each individual transaction. Consequently, the chances of tampering or fraud in the transaction ledger are significantly reduced. Therefore, it fundamentally transforms the field of cybersecurity, serving as a hidden infrastructure that underpins digital activity.

During the provision of the service, blockchain replaces The Blockchain system replaces traditional intermediary parties. Instead of banks (in money transfer), real estate departments (in registering property), traffic departments (in registering vehicles), brokers (in financial transactions), and mediator service companies (such as Uber), millions of people around the world who use blockchain act as mediators, benefiting from the financial outcome that traditional mediators would have received in return for their services[33].

Blockchain technology can be leveraged to support smart contracts as a special protocol that enables individuals who do not have any prior relationship of trust to carry out transactions securely, without relying on a trusted third-party intermediary. Hence, blockchain technology replaces third parties that act as trustees in traditional contracts.

Fourth- *Disabling the modification and termination:*

Currently, there is no avenue to revise smart contracts, which poses a particular risk for the parties involved. If the conventional contract is in written form and the parties agree to amend some of its clauses due to a development in the underlying matter or if there is a change in the text of the law governing it, they are still able to promptly formulate an amendment to its clauses and accommodate this change, or alternatively alter the trajectory of their contractual conduct. Smart contracts, in contrast, do not currently offer such flexibility because blockchains are not easily mutable, modifying a smart contract is inherently more intricate than altering the traditional program code that operates outside of a blockchain framework. To amend it can be costlier than amending a conventionally written contract, and the margin of error is greater since even the formulation of the amendment requires technicians due to the inability of the contracting parties to accurately reflect the amendments to be made.

It should be noted that the smart contracts' automated protocol execution may diverge from traditional contract implementation as they cannot be terminated; the only recourse is their deletion from the blockchain platform by adding a self-destruct feature in their code and granting authority to a person to activate it.

There are initiatives to develop smart contracts that are characterized by their ability to be terminated immediately, as well as their ability to be modified with greater flexibility. This trend, which is partly inconsistent with the immutability of current smart contracts, reflects pragmatic necessity. Smart contracts will only become commercially viable if they accurately reflect real market dynamics and the manner in which the contracting parties interact.

## Chapter II: The Peculiarity of Implementing Smart Contracts in Light of Contract Theory:

Smart contracts are distinguished by their automation, a primary feature facilitated by the blockchain platform. This platform provides the benefits of automaticity and reliability, thereby reducing disputes that may arise from human intervention in contract execution (First Requirement). Nevertheless, the inability of smart contracts to adhere

to certain fundamental principles of contract theory may result in significant penalties, which may be considered as one of the main challenges to their adoption (Second Requirement).

**First requirement: Smart Contract Execution Mechanism:**

Smart contracts are built in a virtual environment using blockchain technology, which allows their execution to be performed autonomously, as follows:

**First section: Smart Contract Self-Execution:**

A key distinction between smart and traditional contracts is their ability to execute and terminate autonomously. Smart contracts clearly spell out obligations that are coded and automatically enforced. These codes are disseminated across multiple computers within the underlying blockchain network[34]. In this context, the blockchain platform plays an important role in establishing the method of the smart contract's self-execution by virtue of the principle of "Deterministic" execution. This principle is exemplified in many blockchain transactions such as the purchase and sale of cryptocurrencies, decentralized finance assets, intellectual property rights, and tokenized real estate.

**Second section: Automation of the Deterministic Execution of Smart Contract:**

Smart contracts are inherently immune to alteration or termination unless these capabilities are deliberately incorporated during the initial design phase. This rigidity poses a major obstacle for broader adoption.

A smart contract automatically and deterministically executes specific rules and functions in coded terms "If this...then that...". The contracting parties record their contractual obligations by translating them into computer language, digitally signing them, authenticating them with a timestamp, and placing them on the blockchain platform. Once the agreed upon terms are verified and their validity is confirmed by the miners, they can be intuitively controlled and automated to be executed reliably without the intervention of any party. Furthermore, depending on the design of the contract, one can discern two types of executions:

a) Immediate execution: The activation of a smart contract is contingent upon specific events and conditions, both within and external to the blockchain platform, upon which its execution

mechanism relies. In instances where the contract's execution necessitates data from the physical world, this information is supplied by a dependable intermediary known as an Oracle. The Oracle serves as the conduit between the blockchain and the real world, providing the essential data required to initiate the smart contract's execution mechanism[35].

b) The Progressive execution: In addition to the immediate execution of smart contracts, the same execution can be designed to be progressive in what we can appellate a "staged execution" across a defined period of time. For example, the broker purchases a significant quantity of a commodity to be delivered to one of his clients in a number of phases and agrees to the transfer value for each delivery. In this case, the smart contract can be useful through the use of an oracle that confirms the reception of the goods and enables the contract to transfer the amount corresponding to each delivery.

Smart contracts have witnessed many improvements since 2015 owing to the Ethereum platform, which is of higher quality than the Bitcoin System and relies on a primary language known as Solidity. This platform allows customers to create their applications on the common shared computer owned by everyone around the world to perform the services of sending, storing and using smart contracts, within the framework of an original contract that is attached to it to complete the stages of the contractual path and execute it in accordance with the clauses contained in the original contract.

**Second Requirement: The smart contract fails to adhere to certain fundamental principles of contract theory:**

In contract theory, certain fundamental principles and standards are imperative for traditional contracts and must be rigorously adhered to. However, these principles do not receive equivalent attention in the context of smart contracts, as they present challenges in terms of operationalization within the execution mechanisms of the latter. Consequently, this results in stringent penalties (First Section) and a restricted scope (second Section).

**First Section: The Severity of the penalties Resulting from the Execution of Smart Contracts**

Smart contracts are strictly executed according to what they are programmed to do, making them incompatible with the following:

*First- The Incompatibility of Smart Contracts with The Theory of Termination:*

The failure of one of the contracting parties to fulfill its obligation gives the other party the right to request the termination of the contract, and the judge has a wide discretion to accept or reject his request, especially if what the debtor did not fulfill is of little importance to the entire obligation, and he may grant him a deadline to fulfill his obligation, especially under certain circumstances that he evaluates.

Moreover, there are many issues that require flexibility and moral tolerance in the traditional contract and give the judge authority to take into account the circumstances of the contract for amendment or termination, a matter that is not available under the smart contract, as it is executed intuitively and automatically, so the judge does not have any authority to accept, reject, or even grant the debtor a deadline for execution in kind, or even to take into account the circumstances of the contract.

*Second- Smart Contracts Are Incompatible with The Theory of Contingency and Force Majeure*:

In traditional contracts, one or both parties may opt to overlook a breach by choosing not to apply stipulated penalties. In instances where a customer is delinquent in payment owing to specific circumstances, the merchant may determine that preserving the long-term business relationship takes precedence over exercising any available rights to terminate the agreement or impose delay penalties.

By extrapolating the text of Article 1218 of the French Civil Code as amended by Article 2 of ordinance n° in 2016-131 and dated February 10, 2016, reforming contract law, and the general regime and proof of obligations, as well as Article 107 of the Algerian Civil Code[36], the judge may intervene in temporal contracts that are executed during a certain period of time and are subject to circumstances that lead to an imbalance between the obligations of the contracting parties in order to restore the contractual balance and modify the obligations incumbent upon them, while this theory cannot be applied in the field of smart contracts that are distinguished by the technique of immutability due to

their integration into blockchain and cannot be modified such as traditional contracts. For example, if a payment is delayed, the smart contract may be programmed to either automatically deduct late fees from the customer's account or restrict the customer's access to a service. Consequently, the smart contracts' autonomous execution may not be in line with the practical realities of business practices they are intended to support, the only recourse available for the contracting parties remains the deletion of the smart contract from the blockchain platform by integrating a "self-destruct" feature in its programming instructions.

Based on the reading of Article 107/3 of the Algerian Civil Code, force majeure makes it impossible to fulfill the obligation due to a foreign cause beyond the control of the contractor, which leads to the dissolution of the contract ipso facto, and with it all the corresponding obligations of the other party. However, the automated nature of smart contracts is an obstacle to the application of force majeure theory, as the debtor cannot invoke it because the contract is automatically executed without having to resort to court and the computer protocol that supports the smart contract does not recognize the concept of force majeure. Therefore, it is impossible to apply the theory of exceptional circumstances (sudden accident or force majeure[37]), all of which contradict the foundations of smart contracts.

One of the solutions proposed by specialists to overcome force majeure and exceptional circumstances in smart contracts is to include a self-destruct function in the contract; however, this function is a double-edged sword because, as it can be used to remove smart contracts from the blockchain platform and transfer digital currencies when emergencies occur, it may also increase the complexity of the development process and open a conduit for its use as a vector in cyberattacks to destroy the contract without the will of the contracting parties, and it can erase all traces of the smart contract from the blockchain records. This is not the case with traditional contracts, which place great importance on keeping copies of the contract in notarial archives, even if the contractual relationship is terminated.

*Third - Failure to Take into Account the Principle of Good Faith and The Idea of Public Order and Public Morality*:

Good faith is one of the principles that has no place in smart contracts, automation of which does not provide consideration to the intention in contracting, contrary to what is established in the general theory of contract.

Consequently, if the application of the idea of public order and public morality, binding force of the contract, reasonable commercial practice and price, unfair price, arbitrary conditions (articles 110 and 184 of the Algerian Civil Code), simple and serious fault and other traditional principles and concepts (article 281 of the Algerian Civil Code), as well as the concept of leniency or judicial revision of the contract, and other principles that are deemed part of the fundaments of the traditional contract to achieve contractual security, all of which cannot be envisioned in the smart contract, which eliminates these concepts in favor of the idea of "If this is realized ... then this ensues" "If this...then that".

## Second Section: The Limited Scope of Smart Contracts and the Inevitability of Change:

A notable aspect of smart contracts is their constrained applicability concerning taxability, as well as their personal and objective scopes, as outlined below:

*First- Smart Contracts Are Not Subject to State Control*

Currently, smart contracts are not subject to state oversight because their conclusion and execution through the blockchain platform takes place outside the scope of the state and its supervisory bodies, which creates the opportunity to carry out actions and transactions that may be contrary to the law or public order and public morals, such as buying and selling shares in illegal ways, selling drugs of all kinds, money laundering, financing organized crime, and other suspicious transactions, not to mention that dealing with digital currencies is still illegal in a number of countries (Algeria, Qatar, Mexico, Qatar, etc.).

Finally, the state is prevented from collecting various taxes and fees levied on the contractual transactions.

*Second- The Limited Scope of Application of Smart Contracts:* We will address it through the following:

a) Limitation of The Substantive Scope: The breadth and narrowness of the substantive scope of smart contracts is determined by

the extent to which legislation accommodates them. If they do not regulate them with restrictions, the substantive scope will be the same as the substantive scope of traditional contracts, and if they do, they may narrow the substantive scope to some types of transactions, such as commercial transactions or transactions on real estate, movables, business, or commercial papers without contracts related to personal affairs. They may also restrict their substantive scope to contracts that are easy to execute on the blockchain and not implemented on more complex contracts, resulting in the substantive scope of smart contracts being narrower than that of traditional contracts.

b) Limitations of the Personal Scope: Many people, if not the majority of them, do not know how to read and interpret the language of encrypted software and deal with digitization, which leads them to be reluctant to contract with smart contracts, especially since they might not even have the necessary experience in dealing with the electronic contract, let alone the newer contract, which is the smart one, which requires a high technical understanding of its mechanisms. This leads to a reduction in the scope of those who deal with it and limits it to a small group of agents who are able to control the use or leverage the expertise of qualified individuals in blockchain technology to contract, execute transactions, and transfer cryptocurrencies.

*Third- The Inevitability of Legal Intervention to Harmonize Modernity:*

From our point of view, we consider that the reluctance to establish a legal regulatory regime for smart contracts and blockchain technology by some legislations, such as the Algerian one, does not mean rejecting this technology for its uselessness or questioning its effectiveness, but it is only out of apprehension and caution given that these contracts need a lot of programmatic analysis and economic thinking, and therefore accepting this idea means rebuilding and restructuring many of the traditional constants and rules in the area of contract law. which will entail a major departure from the human perspective and flexible theories and focus on the economic and technical dimensions based on financial trading and digital encryption, thus creating coordination between the legal and the economic systems in order to find harmony for building a contractual system that keeps pace with the

implementation of contracts in a modern competitive digital environment that responds to the changes in the open legal world.

The Algerian legislator may consider removing the obstacles that prevent the dissemination of smart contracts on a large scale by developing a model law for smart contracts integrated into blockchain in order to take advantage of this new technology in trade and all transactions where it applies, not only that, but also to develop legal mechanisms for resolving disputes related to it in order to achieve legal and contractual security.

## CONCLUSION

Smart contracts, as integrated within blockchain technology, have garnered significant attention from organizations and individuals globally. This interest oscillates between apprehension and audacity in efforts to regulate their formation and execution, given the distinct advantages and challenges they present. These factors have notably influenced their adoption, as smart contracts do not entirely conform to the foundational principles outlined in contract theory.

Consequently, they may offer a substantial advancement to contract theory, thereby necessitating legal frameworks to structure and facilitate their integration with traditional paper-based contracts. This integration is decisive for the routine operations of organizations and individuals who seek to leverage the unique attributes of self-executing digital contracts, aiming to optimize time, effort, and financial resources while mitigating the risks and fraudulent practices associated with paper-based contracts.

***The study resulted in a number of conclusions, the most important of which are:***

- Smart contracts are integrated into blockchain technology, utilizing encrypted algorithmic programs to articulate the terms and conditions of the contract. These programs confer autonomy during the conclusion and execution stages, thereby eliminating the need for a trusted intermediary.

- The processes of publishing, storing, and encrypting smart contracts within the blockchain allow contracting parties to securely access and verify them, ensuring their integrity and protection against tampering. Due to the immutability characteristic of blockchain,

amendments to these contracts remain impossible without creating a new contract or incurring a significant cost.

- In the context of blockchain technology, a standardized definition of a smart contract has yet to be established. Although efforts are underway to adapt legal systems to these technological advancements, most jurisdictions worldwide still lack comprehensive legislative regulation or a specific legal framework, primarily due to the nascent nature of this technology.

- The operational mechanisms of smart contracts encounter challenges related to their inherent nature, rendering them incompatible with certain theories and general principles of contract law.

***The study also resulted in the following recommendations:***

-Fill the legislative vacuum in international and Arab legal systems, especially Algerian legislation, and set a tight legal regimen for smart contracts held through blockchain technology while also striving to harmonize the theory of the contract.

-Keep pace with modern technological and technical developments and learn how smart contracts held through blockchain technology operate according to new methods to deliver their services and build a suitable infrastructure to create a suitable environment for them in a bid to accelerate contractual transactions, reduce costs, and achieve contractual reliability.

-Benefit from the current experiences of pioneering individuals and organizations in the use of smart contracts integrated into blockchain systems that have proven the positive effects of this technology and start planning and preparing to cope with this transformation to encourage and boost the development, innovation, and competitiveness capabilities of organizations and individuals.

Include the necessary mechanisms in smart contracts for them to be more flexible and adaptable to real transactional practices, enabling them to be reconfigured or instructed to pause or interrupt the execution to support contracting parties in tackling exceptional circumstances, and insert clauses that stipulate the applicable law in case of any potential dispute.

- Establish safeguards to preserve data in the case of smart contract termination through the self-destruct feature, in addition to improving

the integrity of contracts by securing access to the system at the level of both the blockchain platform and smart contracts themselves to preserve the principle of data privacy.

-Make more efforts to establish the foundations of blockchain and recognize the transactions conducted through it, promote its advantages to widen the substantive and personal scope of smart contracts, obstacles, and risks that prevent the achievement of its goals.

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