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Smart contracts and their impact on modern transactions: Horizons of digital transformation and legal regulation

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Abstract---This article examines smart contracts as one of the most prominent manifestations of digital transformation affecting legal and economic transactions. This transformation has given rise to a new contractual model based on the automated execution of contractual terms through advanced digital technologies, foremost among them blockchain technology. The study aims to clarify the technical and legal foundations of smart contracts and to analyze the extent of their integration within the general rules of contract law under the Algerian Civil Code, while highlighting their main practical applications and the legal challenges they raise. The study adopts a descriptive-analytical approach by presenting the technical concepts related to smart contracts, followed by an analysis of Algerian legal texts governing electronic transactions. This approach enables an assessment of the position of this contractual model within the national legal system. The study concludes that, despite the advantages smart contracts offer in accelerating transactions and enhancing transparency and trust, they still face a legislative vacuum that requires legal intervention capable of keeping pace with technological developments and ensuring legal security for modern transactions.

Keywords---Smart contracts, digital transformation, blockchain, Algerian Civil Law, electronic transactions.

Introduction

Recent decades have witnessed a remarkable expansion in the adoption of digital technologies within economic, legal, and administrative systems, leading to a reconfiguration of transaction mechanisms and methods of exchanging benefits and obligations between individuals and institutions. This transformation has contributed to the emergence of new forms of digital interaction, introducing non-

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traditional tools and standards that have affected the nature of contractual relationships and prompted a reconsideration of many classical concepts upon which traditional contracts are based.

Within this context, smart contracts have begun to assert themselves as a new contractual model interacting with the modern digital environment, combining familiar contractual structures with the technical rules that govern them. Although these contracts do not differ in essence in terms of purpose, the manner in which they are drafted, operated, and reliant on advanced digital infrastructure raises several legal questions, whether concerning their technical foundation or their compatibility with traditional rules governing contract formation and execution.

Developments related to smart contracts raise multiple issues regarding their applicability within different legal systems, particularly where national legislation remains confined to classical forms of contracts without explicit extension to such modern digital practices. Many countries are therefore seeking to accommodate this rapid growth, which necessitates evaluating this contractual model and determining its position within the Algerian legal system in light of the ongoing digital transformation.
Based on the foregoing, the following research question is raised: **How do smart contracts affect the development of modern transactions in light of technological innovation and legal requirements?**

This main question gives rise to several subsidiary questions:

- What is the technical foundation of smart contracts?
- How does the Algerian Civil Code and related digital legislation view this contractual model?
- What are its most prominent applications in the fields of economy, commerce, administration, and law?
- What are the legal challenges and prospects for national regulation?

Significance of the Study

The significance of this study lies in analyzing the technical and legal foundations of smart contracts and linking them to the Algerian civil legal system, in addition to evaluating their impact on modern transactions and the legislative challenges they raise.

Objectives of the Study

- To identify the technical and legal nature of smart contracts and the extent of their compatibility with the general rules of contract law, while highlighting their main practical applications.
- To examine legal challenges and explore prospects for their regulation in Algeria.

Section One: Smart Contracts between Technical Foundations and Legal Regulation

Combining the technical and legal dimensions of smart contracts represents a necessary entry point for understanding the nature of these contracts and the manner in which legislation deals with them. Accordingly, this study begins by examining the technical foundations upon which smart contracts are based, before moving on to clarify their position within the Algerian legal system. Based on this approach, this section is divided into two subsections: the first addresses the technical foundations of smart contracts, while the second examines their legal regulation under Algerian legislation.

First Subsection: The Technical Foundations of Smart Contracts

Smart contracts cannot be examined without an understanding of the technical framework that gave rise to them, as their structure and operating mechanisms are closely linked to the digital developments witnessed in information technology. This requires addressing their definition, origins, and the technical characteristics that distinguish them.

First Branch: Definition and Emergence of Smart Contracts

Smart contracts are considered one of the most significant technical outputs of modern blockchain systems, which are based on the digital currency protocol "Bitcoin." Through these systems, software programs complete contractual processes by executing contractual clauses without human intervention.

Given the novelty of smart contracts, there is no unanimous agreement on a precise definition. In the absence of clear legal texts defining this type of contract, several definitions have emerged. Nick Szabo, regarded as the theorist of smart contracts, defined them as "a set of promises, specified in digital form, including protocols within which the parties perform on these promises," noting that these protocols are typically executed on computer networks or other forms of digital electronics. Accordingly, these contracts are considered "smarter" than traditional contracts and do not rely on artificial intelligence for their execution **(Qashta, 2024, p. 4).**

Smart contracts have also been defined as digital programs based on blockchain technology that execute themselves once the agreed-upon conditions are fulfilled. Due to their decentralized structure, they are self-executing and difficult to alter or tamper with **(Obeidat, 2022, p. 6).**

The French jurist Jean-Christophe Roda defined smart contracts as computer programs designed to automatically execute agreed contractual terms without third-party intervention. Similarly, Mustapha Mekki argued that smart contracts are not contracts in the strict technical sense, but rather computer programs that enable certain acts or legal dispositions to be carried out automatically **(Al-Soussi, p. 53).**

Jaccard defined smart contracts as programs that link computer code between two or more parties in order to execute predetermined effects, and which are stored in a distributed ledger **(Mohamed, 2021, p. 86).**Abdel-Sattar Abu Ghudda defined smart contracts as encrypted protocols implemented through software capable of transferring contracts from one person's account to another via blockchain platforms, without the intervention of a third party such as a notary, intermediary, or central authority **(Haqsha, 2023, p. 567).**

They have also been defined as contracts between two or more parties that are self-executing through protocols based on mathematical symbols known as algorithms, containing all information related to the parties' rights and obligations and ensuring the execution of all contractual clauses through blockchain technology **(Al-Omari, 2022, p. 93).**

It is evident that most of these definitions emphasize blockchain technology as the core feature of smart contracts. These contracts enable communication and data exchange among users and do not rely on state enforcement for execution; rather, they ensure automated performance of obligations agreed upon by the parties **(Mohamed, 2021, p. 86).**

Based on the foregoing, a smart contract may be defined as a contract that is executed automatically through a program relying on a blockchain system or platform, containing data and codes through which offer and acceptance are expressed, and which is executed automatically once the agreed conditions are met.

The concept of smart contracts first appeared in 1994 through the American computer scientist Nick Szabo. However, their actual implementation occurred in 2013 as a result of the second generation of blockchain technology, namely the Ethereum platform, which introduced a programming language different from that of digital currencies. This allowed the performance of diverse operations, making smart contracts the second major application of blockchain after cryptocurrencies. Smart contracts rely on representing financial assets and private property (such as real estate, vehicles, benefits, and rights) in the form of digital codes uploaded to the blockchain and linked to their owners through encrypted accounts and digital wallets. This enables transactions such as sale, purchase, lease, and mortgage to be

conducted via blockchain platforms in a manner similar to dealings with cryptocurrencies **(Hachach, 2024, p. 17).**

The smooth operation of smart contracts depends on a combination of blockchain technology, code execution, and decentralized consensus. The mechanism of smart contracts can be summarized as follows **(Academy, 2025):**

1. **Creation and Deployment:** A smart contract developer creates a contract using a programming language compatible with a blockchain platform (such as Solidity for Ethereum or Rust for Solana), after which the contract is deployed on the blockchain network and becomes part of its decentralized system.
2. **Code and Conditions:** The smart contract contains programmed instructions defining the terms and rules of a specific agreement, application, or transaction, which may range from simple payment processes to complex multi-step operations involving multiple participants.
3. **Contract Activation:** Once deployed, any user with access to the blockchain may activate the smart contract by interacting with it, usually by invoking specific functions and providing required inputs. Most interactions with decentralized finance services and decentralized applications through digital wallets such as MetaMask or Phantom rely on smart contracts.
4. **Verification and Execution:** Upon activation, the blockchain network verifies and audits the transaction. If the contract's conditions are met, the task is executed automatically.
5. **Immutable Records:** Once verified, the transaction is recorded as an immutable entry in the blockchain database, ensuring transparency, traceability, and auditability.
6. **Finality:** Smart contract execution is final and irreversible, as it is stored in a tamper-resistant decentralized ledger, ensuring transaction integrity and security while reducing risks of fraud or unauthorized modification.

Second Branch: The Multiple Characteristics of Smart Contracts

Smart contracts rely on an advanced technical infrastructure based on blockchain technology, granting them distinctive characteristics that govern their creation, execution, and management, and making them more attractive and widely accepted than traditional contracts. These characteristics extend beyond purely technical aspects to include non-technical features that collectively shape the concept and practical application of smart contracts. The most significant characteristics include:

1. **Decentralization:** Smart contracts operate on decentralized blockchain networks, allowing information transfer and transaction execution without a central authority, unlike centralized systems **(Al-Rahman, 2022, p. 470).**
2. **Security and Encryption:** Smart contracts and their data are secured through advanced encryption techniques and complex algorithms, making them resistant to forgery and manipulation.
3. **Immutability and Traceability:** Once deployed, a smart contract cannot be modified or revoked unless its design allows for such changes. All transactions are recorded and time-stamped on the blockchain.
4. **Autonomy and Transparency:** Smart contracts eliminate the need for intermediaries, enforce themselves automatically upon fulfillment of conditions, and provide transparent access to contractual information, reducing disputes.
5. **Trust and Accuracy:** The secure and tamper-resistant nature of smart contracts enhances trust among parties and ensures precise execution of detailed contractual terms.
6. **Speed and Efficiency:** Smart contracts reduce time, effort, and costs by eliminating intermediaries and administrative procedures, unlike traditional contracts that require extensive documentation and processing time.

Due to these characteristics, smart contracts are also referred to as:

- **Digital Contracts**

- **Self-Executing Contracts**
- **Crypto Contracts (Qashta, 2024, p. 6)**

Second Subsection: Legal Regulation of Smart Contracts under Algerian Legislation

After defining smart contracts and clarifying their technical foundations, it becomes necessary to examine their position within the general rules of Algerian civil law and assess the extent to which the legislative framework accommodates the digital technologies associated with them. This subsection addresses the legal status of smart contracts within civil law (first branch) and the position of the Algerian legislator regarding relevant digital technologies (second branch).

First Branch: Legal Regulation of Smart Contracts within the General Rules of Contract Law

Algerian law recognizes contractual freedom, based on the principle that contracts are generally permissible. This principle is significant in establishing the legitimacy of smart contracts, as parties are free to conclude contracts provided substantive and formal requirements are met. What applies to traditional contracts applies to smart contracts, with the primary difference being the form and mechanism of execution.

Despite their technical nature, smart contracts do not, in principle, fall outside the general theory of contract under civil law. Their designation as "contracts" confirms this, as they are based on the concurrence of wills aimed at creating legal obligations. Consequently, they remain subject to traditional contractual elements—consent, object, and cause—provided these elements can be verified within the digital environment. Expression of will occurs through programming code as a modern means of manifestation, provided that consent is genuine and the object of the obligation is lawful and possible.

However, subjecting smart contracts to general civil contract rules raises practical challenges, notably difficulties in verifying legal capacity and defects of consent, such as mistake or duress, within an automated execution framework. Additional issues arise concerning the determination of the time and place of contract formation and execution, which affect jurisdiction and applicable law in the event of disputes. Moreover, the immutability of smart contracts conflicts with civil law principles allowing contract modification or termination due to non-performance or unforeseen circumstances, such as force majeure **(Jassim, 2021, p. 357).**

Second Branch: The Position of Algerian Legislation toward Relevant Digital Technologies

An examination of the Algerian legislator's position on digital technologies related to smart contracts reveals a cautious and gradual approach. To date, no specific legislation directly regulates smart contracts or blockchain technology. However, certain aspects of digital transformation have been addressed through general legal texts that indirectly contribute to regulating these contracts.

This is evident in the recognition of electronic commerce contracts concluded remotely through digital means under Law No. 18-05 of May 10, 2018, which governs electronic commerce and recognizes the validity of electronically concluded contracts provided they meet the general contractual requirements set out in the Algerian Civil Code.

Additionally, Law No. 15-04 on electronic signature and certification constitutes a fundamental reference for determining the evidentiary value of electronic documents, granting electronic signatures the same legal force as traditional signatures when statutory conditions are fulfilled. This is essential for digital contracting. Law No. 18-07 of May 10, 2018, concerning the protection of personal data, also forms part of the relevant legal framework.

Despite these texts, which reflect partial recognition of digital tools as legitimate means of concluding legal transactions, Algerian legislation still lacks explicit provisions regulating smart contracts or blockchain technology. This constitutes a legislative gap, as existing laws address traditional electronic contracts without addressing the specificities of automated, code-based contracts, thereby subjecting smart contracts to the general rules of contract law under the Algerian Civil Code.

Section Two: The Impact of Smart Contracts on Modern Transactions between Advantages and Legal Challenges

The emergence of smart contracts has generated tangible transformations in contemporary transactions, whether at the level of economic, commercial, and administrative practice, or at the level of the legal issues they raise. Consequently, analyzing their impact requires first examining their practical applications (First Requirement), and then addressing the challenges and regulatory prospects (Second Requirement).

First Requirement: Practical Applications of Smart Contracts in Modern Transactions

The use of smart contracts has become a tangible reality in many sectors, as they have found wide applications in the economic, commercial, legal, and administrative fields. This necessitates highlighting their most significant applications and analyzing their impact on modern transactions.

First Branch: Practical Applications of Smart Contracts in the Economic and Social Fields

Rapid digital transformations, accompanied by advances in blockchain technologies, have led to the emergence of smart contracts as a modern contractual tool with a clear impact on the economic and commercial fields. This type of contract has enabled the automatic and immediate execution of contractual obligations once the pre-agreed conditions are met, without the need for human intervention or traditional intermediaries. This has positively affected the efficiency of economic transactions.

In the economic field, smart contracts are increasingly used in digital financial operations such as transfers, electronic payments, and smart insurance. They contribute to reducing operational costs, accelerating transaction execution, and minimizing risks associated with non-performance or delays, while enhancing trust between contracting parties through reliance on tamper-resistant technical systems.

In the commercial field, smart contracts have contributed to the development of mechanisms for concluding and executing commercial contracts, particularly in e-commerce and supply chains. These contracts can be programmed so that payment or transfer of ownership is executed automatically upon fulfillment of delivery or receipt conditions, with all stages of execution documented on a secure digital network. Their applications also extend to international commercial contracts, where they help reduce reliance on intermediaries and overcome certain issues related to the multiplicity and diversity of legal systems by providing a unified execution mechanism based on pre-established technical rules.

However, despite the tangible economic and commercial benefits they offer, these practical applications remain dependent on the availability of an organized legal framework capable of accommodating the specificity of smart contracts and ensuring a balance between technological innovation and the protection of the legal positions of contracting parties.

Second Branch: Practical Applications of Smart Contracts in the Administrative, Legal, and Judicial Fields

Smart contracts have given rise to increasing practical applications in the administrative and legal–judicial fields, contributing to the modernization of public service management and the execution of legal obligations in line with digital transformation requirements. In the administrative field, smart contracts are used to automate a number of contractual procedures, such as managing public

procurement, granting licenses, and monitoring the execution of administrative obligations by programming specific legal conditions under which obligations are automatically executed once regulatory requirements are met. This contractual model helps accelerate procedures, reduce administrative delays, enhance transparency, and provide a reliable digital record of all administrative operations that can be consulted when needed.

In the legal and judicial field, practical applications of smart contracts appear primarily in the execution of contractual obligations, as they enable the automatic enforcement of contractual effects according to pre-agreed terms, thereby reducing cases of non-performance or delay. Smart contracts are also used to support electronic arbitration mechanisms by linking the execution of obligations to digital arbitral decisions, allowing for swift and efficient enforcement. Moreover, smart contracts are adopted as a supportive technical means for proving legal transactions, given the precise digital documentation they provide regarding the date of contract conclusion, its terms, and stages of execution. These applications contribute to enhancing judicial efficiency and reducing the burden on courts by decreasing disputes related to contract performance, without undermining the general legal rules governing contractual relationships.

Second Requirement: Legal Challenges and Future Prospects for the Regulation of Smart Contracts
Despite the advantages offered by smart contracts, they raise a number of legal challenges that require precise legislative treatment. Accordingly, it is necessary to identify the most prominent challenges and then explore future prospects for regulating this type of contract in Algeria.

First Branch: Current Legal Issues Related to Smart Contracts
Smart contracts currently face several legal issues that reflect the lack of readiness of traditional legislative systems to accommodate this newly emerging contractual model, hindering its full integration into the legal system. This is mainly due to the unique technical nature of smart contracts compared to conventional civil contracts.

One of the most prominent issues is the absence of explicit legal regulation defining the legal nature of smart contracts and clarifying their position within existing legal classifications—whether as an advanced form of electronic contract or as an independent contractual model. Civil legislations, including Algerian law, still rely on traditional concepts for contract formation and execution. Additionally, evidentiary issues arise due to smart contracts' reliance on digital technical means to express intent and document obligations, which requires adapting traditional rules of evidence to accommodate this new contractual form.

Furthermore, smart contracts raise issues related to the execution of obligations, particularly given their automatic nature, which may not always align with certain general legal principles, such as the possibility of suspending or modifying execution in exceptional cases. Difficulties also arise in determining legal liability when technical or programming errors affect contract execution, as well as issues related to jurisdiction and determining the applicable law in cross-border smart contracts.

The integration of smart contracts into the existing legal system raises numerous challenges. These challenges relate, first, to the essential elements of the contract, particularly consent and the verification of the legal capacity of the contracting parties. They also extend to issues concerning the object and the cause of the contract, which require ensuring the contract's legality through compliance with the legal conditions governing both the object and the cause. In this context, the object of the contract may be lawful in the country of one contracting party but unlawful in that of the other. Moreover, the concept of cause, in its objective dimension as a basis of the contract, varies according to the public order of each State. Additional challenges arise with respect to the interpretation and execution of smart contracts, including issues related to specific performance, termination of the smart contract, and the

defense of non-performance, as well as the application of the doctrines of unforeseen circumstances and force majeure, given the automated nature of these contracts (Al-Othman, 2024, pp. 48–49).

Second Branch: Prospects for Legal Regulation and Recommendations for Modernization

The development of smart contracts opens wide horizons for legislators to modernize legal systems in line with digital transformation, either by integrating this contractual model into the general rules of contract law or by enacting specific legislation governing it. Explicit legal recognition of smart contracts constitutes a fundamental step toward ensuring transaction stability and enhancing legal certainty for contracting parties, alongside establishing clear rules governing contract formation, execution, proof, and dispute resolution.

Regulatory prospects also highlight the necessity of adapting traditional civil rules to the technical specificity of smart contracts, in a manner that achieves a balance between the principle of freedom of contract and the requirements of legal protection for parties. In this context, legislative recommendations tend toward adopting a gradual approach based on updating existing provisions in civil law and electronic transaction laws, while benefiting from comparative experiences without undermining national legal specificity. It is also advisable to strengthen the legal framework supporting digital transformation by developing electronic evidence rules, supporting electronic arbitration and litigation mechanisms, and training judges and legal professionals in technical aspects related to smart contracts. Such legislative modernization is expected to contribute to providing a flexible legal environment capable of accommodating smart contracts and ensuring their safe and effective use across various fields of modern transactions.

Conclusion

Digital transformation and the modern technologies it has generated—particularly smart contracts—have constituted a significant turning point in the evolution of legal and economic transactions. Contracts are no longer merely traditional legal instruments but have become integrated within a complex digital environment that combines legal rules with technical requirements. This study has sought to examine the nature of smart contracts by analyzing their technical foundations, their position within the Algerian legal system, their practical applications, and the challenges they raise.

Based on the foregoing analysis, the study has reached the following findings and recommendations:

First: Findings

1. Smart contracts represent a modern contractual model based on blockchain technology, relying on the automatic execution of contractual clauses without human intervention, while retaining the essence of the contract based on mutual consent.
2. In principle, smart contracts do not fall outside the scope of the general theory of contract in Algerian civil law; however, their mechanisms of formation and execution raise specific legal issues.
3. Algerian legislation still lacks explicit legal regulation of smart contracts, relying instead on general provisions related to electronic contracts, electronic signatures, and data protection.
4. Practical applications of smart contracts reveal their growing role in economic, commercial, administrative, and legal fields, due to the speed, transparency, and reduction of costs and risks they provide.
5. Smart contracts raise multiple legal challenges, particularly regarding evidence, determination of liability, adaptation of contract elements, and execution of obligations in light of their automatic and immutable nature.
6. Regulating smart contracts in Algeria remains a future legislative challenge requiring a balanced legal vision that accommodates digital-age requirements without undermining the foundations of the traditional legal system.

Second: Recommendations

1. Enacting explicit legal regulation recognizing smart contracts and defining their legal nature and scope of application, either within the civil code or through specific digital transactions legislation.
2. Adapting general contract rules and rules of evidence to align with the technical specificity of smart contracts, while ensuring the protection of parties' intent and legal positions.
3. Strengthening the legal framework for digital transformation by supporting electronic signatures, electronic litigation and arbitration, and training judges and professionals in the technical aspects related to smart contracts.
4. Benefit from comparative legislative experiences while taking into account national legal particularities, to ensure a balance between encouraging technological innovation and guaranteeing legal security in transactions.

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