



## **Blockchain-based smart contracts and their potential to develop some financial and banking operations in Iraq**

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### **Abstract**

This research explores the great potential of blockchain based smart contracts in Iraq's financial and banking sector. It looks into how this technology can improve financial operations by automating transactions and reducing operational cost, increasing transparency, and reducing intermediaries. The research also tackles the challenges of adoption such as lack of digital infrastructure and lack of legal frameworks and cybersecurity risks. The findings show that smart contracts can lead to higher operational efficiency and more strategic flexibility for financial institutions in Iraq. Therefore, the research recommends developing digital infrastructure and establish comprehensive regulatory frameworks to support smart contracts and digital transformation in the financial and banking sector according to international standards.

**Keywords:** Blockchain; Digital infrastructure; Cybersecurity risks

### **1. Introduction**

In the last few decades, the world has witnessed rapid technological advancements that have changed many sectors, with the financial and banking industry leading the pack. Financial institutions are adopting innovative technologies to improve their performance, efficiency and meet the demands of customers in a digital world. Among these technologies, blockchain has emerged as a game changer that has redefined data storage and verification through its decentralized architecture, robust security and transparency in transactions. Blockchain operates on an immutable and shared digital ledger, a transparent environment for storing and sharing information without a central authority, and advanced encryption and protection. With the rise of blockchain many applications have surfaced, most notably "smart contracts". These contracts are seen as a solution, vast potential to develop financial processes and automate. Smart contracts with their ability to execute operations independently without human intervention open up new avenues to create new financial models, reduce costs and speed up transactions. The focus on these technologies highlights their potential to support digital transformation in the financial sector, make processes more efficient and adaptable especially in countries that want to sustain their financial institutions. In Iraq, the need to adopt modern technologies has become crucial to drive progress in the financial sector and keep up with the global market changes. Adopting smart contracts is a strategic step to improve the performance of financial and banking institutions in the country. This technology offers opportunities to enhance transparency and security, operational efficiency and reduce dependence on traditional methods that hinder sector growth. As awareness of digital transformation rises, adopting such tools is imperative for Iraqi institutions to build advanced infrastructure that can meet the digital economy aspirations. This adoption will position Iraq to strengthen its financial competitiveness and leverage technology for sustainable economic growth according to global standards and trends. Against this backdrop, this research aims to provide a comprehensive understanding of the role of smart contracts in reshaping the financial and banking infrastructure in Iraq. It will explore the capabilities of smart contracts and evaluate the benefits they can bring to improve financial

performance while addressing the technical, legal and economic challenges that may hinder their application. Moreover, the study will examine the impact of this technology on Iraq's digital economy and propose a forward-looking vision to enable the Iraqi financial sector to fully harness the potential of smart contracts amidst the existing challenges. Through this analysis, the research hopes to provide practical insights to guide financial institutions and policymakers to adopt effective strategies to support Iraq's digital transformation align with global economic demands and enhance the country's regional and international competitiveness.

## **2. Blockchain**

### **2.1 An Overview of Blockchain**

Blockchain technology represents a groundbreaking and remarkable shift in how data is stored and information is exchanged in a decentralized way. This concept goes back to the early 1990s when researchers Stuart Haber and W. Scott Stornetta in 1991 developed a system to protect digital records with what is called digital timestamps. This system ensured digital documents could not be altered or forged; it was a powerful tool for digital data integrity (Haber & Stornetta, 1991). While this laid the foundation for advanced protection mechanisms in digital record keeping, the practical and widespread application of the concept was only realized with the birth of the cryptocurrency Bitcoin in 2008. Introduced by an individual or group under the pseudonym "Satoshi Nakamoto", Bitcoin was the first real world implementation of blockchain technology (Nakamoto, 2008). This was not just a breakthrough in digital currency but also a foundation for a reliable way to record transactions in a decentralized way, transparent and secure. It has since become the backbone of many advanced digital applications. Blockchain technology works on a sequential structure of units called "blocks". Each block contains a collection of transaction data like sender and receiver identifiers and the timestamp of the operation. These blocks are linked through a unique identifier called "hash" which is an encrypted code linking one block to the previous one. This sequential linkage ensures data integrity and prevents any attempt to alter or manipulate the records without alerting the rest of the network participants. If any modification occurs in one block, the entire hash chain is affected, so the network can detect changes easily. This interconnectivity makes it trustable and resistant to tampering, as all nodes in the network maintain a copy of the distributed ledger. Nodes which are all the computing devices participating in data verification and recording in the blockchain network play a crucial role in decentralization and system robustness (Zheng et al., 2017). Transaction validation in blockchain networks relies on what is called the "consensus mechanism", the core process of the network. This mechanism uses complex mathematical models and software to verify every transaction added to the network, requires approval from the majority of the nodes. One of the most popular consensus mechanisms is Proof of Work (PoW) which requires participating nodes to perform complex mathematical computations for every transaction on the network. This ensures transaction security and completion, making it extremely difficult to alter any information in the blocks without controlling more than half of the network's active nodes – a process that is technically impossible and very costly (Vukolić, 2015).

### **2.2 Types of Blockchain**

The development of blockchain and its increasing use across many industries has led to different types of blockchain, each with its own structure and technical features to suit modern applications.

**2.2.1 Public Blockchain:** This is the most used type of blockchain, used in cryptocurrencies like Bitcoin, Ethereum, Litecoin and others (Swan, 2015). Public blockchains are open source and transparent, all network users can view and verify transactions. They are fully decentralized; no single entity controls or monopolizes the network. However, public blockchains have challenges like slow data processing and high operational cost due to its large network size (Nofer et al., 2017).

**2.2.2 Private Blockchain:** Private blockchains are not public and are governed by a central entity (organization or company). Access is restricted to authorized individuals (Pilkington, 2016). They are faster and cheaper in transaction processing, as they do not require approval from many nodes. Private blockchains are easier to manage and control but can be manipulated if not managed transparently (Drescher, 2017).

**2.2.3 Consortium Blockchain:** Also known as, federated blockchain, this type is a middle ground between public and private blockchains and is managed by a consortium of participating organizations or entities. It is used in industrial alliances, banking systems, and inter-company networks. Consortium blockchains are fast in transaction processing and operational efficiency while maintaining internal transparency among members. However, they can face challenges in scalability and trust management among diverse participants (Zyskind et al., 2015).

**2.2.4 Hybrid Blockchain:** Hybrid blockchains combine features of public and private blockchains, allowing controlled access to some data while keeping others transparent. This makes them suitable for applications that require flexibility in data management (Xu et al., 2019). They are used in scenarios that require a balance between transparency and privacy such as government data and healthcare systems. Hybrid blockchains are good at dynamically customizing data according to needs but require technically complex designs to harmonize public and private components (Khan et al., 2021).

### 3. Smart Contracts

#### 3.1 The Concept of Smart contracts

Smart contracts represent one of the most sophisticated applications of blockchain technology that have the potential to transform, by their very being, the conventional contracts from an analog to a digital format, as they are executed by their conditions automatically without intervention by a third party or central authority, thus leading to a massive cut down in time and cost related to intermediaries. The conceptualization of smart contracts can be traced back to the early 1990s and to the writings of computer scientist Nick Szabo, who cleverly defined smart contracts as digital protocols meant to ensure the automatic execution of agreements among different parties. Once the participants get a sufficiently transparent and trustworthy mechanism with which to interact, there is no need for intermediaries (Szabo, 1997). Thus, several years of a theoretical stage of existence only underscored the necessity of an environment that required decentralization to come into being with focused support for these smart contract concepts' actual implementations. Smart contracts could only come into practical implementation using the new blockchain technology, subtly changing the ways of documenting digital transactions in a decentralized manner. The early incarnations of blockchain networks such as Bitcoin were conceived to enhance the capacity for facilitating financial transactions. The system was initially focused on the recordation and security system for any financial transaction in a secure and nexuses-free set-up, but as a series of Boolean commands, they were found wanting in businesses and, consequently, smart contracts were not able to function fully during the initial stages of their recognition. The initial blockchains were not able to run the programmatic command called for to invoke smart contracts, hence frustrated their demand to function well, and to a great extent pragmatically. Vitalik Buterin, specifically designed to support smart contracting and to prove the drawbacks in the traditional blockchain architecture, crossed this limitation in 2015 with the establishment of the Ethereum network. The development of the Solidity programming language consequently gave developers the chance to build Smart Contracts able to run complex, self-executing instructions within the system (Jaganathan et al., 2023). This flexible platform enabled developers to create decentralized applications (DApps), which heavily rely on smart contracts. These applications can now integrate beyond cryptocurrencies, expanding to decentralized finance (DeFi), insurance contract management, supply chain management, and others. Hence, Ethereum became more than a cryptocurrency platform; it grew into a complete ecosystem carrying smart contract capabilities, whereby various types of innovative applications to meet multiple requirements in terms of being secure and reliable in execution were developed. With those advancements in place, smart contracts stood on firm ground in various sectors as they offered decentralized technological solutions to aid in improving efficiency and transparency. Their widespread acceptance acknowledges the protocol for its future role in the realm of new technologies.

#### 3.2 Characteristics of Smart Contracts

**3.2.1 Decentralization and Elimination of Intermediaries:** Decentralization, in smart contracts, is a very crucial feature in the sense that there is no centralized authority doing things such as validating or executing transactions. Once again, all participants accessing information on the contracts strip intermediaries away with their cost of transactions, making for efficient business operations. This decentralized capability inherently limits situations of fraud or mismanagement permitted by intermediaries. According to Teng (2022), therefore, decentralization makes smart contracts reliable and fast, and thus transaction efficiency increases.

**3.2.2 Automatic Execution of Transactions:** One of the biggest advantages of smart contracts is they can execute transactions automatically. These contracts are built on rules that are programmed to ensure the conditions of the agreement are met without human intervention. As Hillbom and Tillström (2016) say, this reduces the chance of errors or delays, so transactions are faster and more streamlined.

**3.2.3 Encryption and Security:** Encryption is a foundational element of smart contracts, utilizing robust cryptographic methods to secure data and transactions. Built on blockchain technology, smart contracts are resistant

to tampering or unauthorized alterations. As noted by Mohanta et al. (2018), encryption safeguards sensitive information related to the contract, ensuring the confidentiality and security of the data.

**3.2.4 Speed:** Transaction speed is a key feature that differentiates smart contracts from traditional systems. Once the conditions are met, the contract is executed within minutes, depending on the size of the transaction and the network's capacity. As Bhat et al. (2021) say, speed of execution is important for blockchain-based systems especially in financial and banking applications.

**3.2.5 Transparency:** Smart contracts are designed to be transparent, so all parties involved can see the data and agreements. This transparency allows stakeholders to monitor the contract execution and verify the terms, so trust is built and potential disputes are reduced (Sakib, 2024).

**3.2.6 Immutability:** Once on a blockchain, smart contracts are unchangeable, so the agreed terms cannot be changed or modified. As Vasiļevska (2022) says, this prevents contract manipulation, so it is more credible.

## 4. Applications of Smart Contracts in Financial and Banking Sectors

### 4.1 Decentralized Finance (DeFi):

Decentralized Finance (DeFi) is a modern means of financial intermediation, which defies traditional intermediaries such as banks or financial institutions and therefore opens novel opportunities for individuals to get connectivity with a plethora of financial services. This is primarily founded on the Smart Contract technology that ensures the safe and efficient management of financial activities involving lending, trading, and managing crypto assets. Smart contracts enforce financial agreements automatically without third parties, makes it transparent and cost-effective. Examples of DeFi applications are Aave, Compound and Uniswap, which uses smart contracts to facilitate decentralized trading, lending, borrowing and asset custody (Schär, 2021). Despite the growth of this space, it has many technical and regulatory challenges. DeFi has liquidity constraints compared to traditional financial systems and struggles to build user trust due to regulatory and legislative ambiguity. Security and asset protection is also a big issue. Nevertheless, DeFi is a promising space that can change the financial landscape, offers new opportunities for investment and financial services especially in areas without access to traditional financial systems. However, its growth and adoption depends on solving these challenges, liquidity, trust and regulatory clarity (Metelski & Sobieraj, 2022).

**Table (1):** Forms of Decentralized Finance (DeFi)

Form of Financing	Description
<b>Lending and Borrowing</b>	Platforms enabling users to lend and borrow digital assets via smart contracts without traditional intermediaries, such as Aave and Compound.
<b>Decentralized Trading (DEX)</b>	Allows users to trade cryptocurrencies without relying on centralized platforms, leveraging protocols like Uniswap and SushiSwap.
<b>Digital Savings</b>	Enables users to deposit their savings (e.g., cryptocurrencies) into specific protocols in exchange for fixed or variable returns, such as BlockFi and Binance.
<b>DeFi Crowdfunding</b>	Facilitates investment in projects or startups through decentralized crowdfunding platforms, such as Gitcoins and DAOs.
<b>DeFi Staking</b>	Users can lock or stake their digital assets to support certain decentralized finance networks in exchange for rewards, such as Yearn and Polkadot.

### 4.2 Trade Finance:

Smart contracts enhance trade finance operations such as letters of credit and guarantees by integrating with technologies like IoT and sensors, enabling seamless automation of information. For instance, in letters of credit, combining smart contracts with smart sensors automates payment verification when shipment conditions are met. Sensors relay real-time data to the smart contract, which processes payments without human intervention, reducing settlement delays (Tian, 2016). In guarantees, smart contracts with IoT ensure compliance. For instance, in asset-backed loans, sensors monitor equipment status on the blockchain. If equipment is moved to unauthorized locations

or damaged, updates alert relevant parties. This synergy between smart contracts and IoT fosters transparency and reduces fraud risks, making financial systems more secure and efficient (Tapscott & Tapscott, 2017). Platforms like **TradeLens**, **MarcoPolo**, and **WeTrade** are notable for automating trade finance operations alongside various banks and institutions.

#### **4.3. Insurance Services:**

The insurance sector increasingly leverages smart contracts for secure and efficient automation of insurance operations, minimizing human involvement. These contracts improve operational efficiency by expediting claims processing. For example, insurers can automate payments when predefined conditions are met, such as a car accident report. Upon data entry, the smart contract verifies its accuracy and processes payment, reducing errors and enhancing customer satisfaction (Christidis & Devetsikiotis, 2016). Companies like **Etherisc** demonstrate how smart contracts revolutionize insurance services. Etherisc's flight delay insurance automates compensation based on external data sources when delays occur, streamlining the customer experience (Sedkaoui & Chicha, 2021).

#### **4.4. Know Your Customer (KYC) System**

KYC processes, essential for verifying client identities and preventing illicit activities like money laundering, benefit significantly from smart contracts. Automating KYC through smart contracts reduces costs by up to 30% in identity management (Ya, 2020). By sharing verified and standardized data among network participants, redundant processes are minimized, accelerating operations. Additionally, embedding compliance requirements into smart contracts ensures adherence to local and international regulations, reducing the risk of penalties (Martens et al., 2017).

#### **4.5. Securities Settlement Systems**

Smart contracts have changed the game for securities settlement and clearing in financial markets by using blockchain for faster and more secure settlements. This means less operational costs and human effort. For example, the Australian Securities Exchange (ASX) did the CHESSE Replacement Project that used blockchain and smart contracts to reduce settlement time from 2 days to minutes (Agarwal et al., 2023). The Depository Trust & Clearing Corporation (DTCC) launched the ION Project a distributed ledger system for large-scale financial trades with speed and security. Other initiatives include Synapse launched by the Hong Kong Stock Exchange, which reduces operational risks and settlement delays by real-time data synchronization across time zones and integration with DTCC's Institutional Trade Processing (ITP) service (Colle, 2021).

### **5. Smart Contracts in Financial and Banking Sector Challenges**

Despite the numerous advantages offered by smart contracts, including process automation, faster transactions, enhanced security, and reduced operational costs, their adoption in financial and banking institutions is hindered by several challenges and risks.

#### **5.1 Cybersecurity Risks and Challenges**

Cyber threats are among the most significant challenges facing the application of blockchain and smart contract technologies in the financial sector. While designed to provide high levels of security through encryption and data decentralization, vulnerabilities can still be exploited by hackers and criminal organizations. For instance, Distributed Denial of Service (DDoS) attacks can disrupt networks, affecting or halting banking operations. Moreover, the lack of integration between traditional systems and smart contracts often creates security gaps, further complicating the cybersecurity landscape. Financial institutions must adopt multilayered strategies to bolster cybersecurity and mitigate these risks (Hashimzai & Ahmadzai, 2024).

#### **5.2 Legal and Regulatory Challenges**

Smart contracts have many legal and regulatory challenges that hinder their implementation in various sectors including finance and banking. One of the biggest challenge is the lack of clear legal framework governing their use. Most of the existing regulations are not designed to address the unique characteristics of this technology such as decentralization and immutable data records making it difficult to assign legal responsibilities. This raises the question of how current laws can be applied to transactions done through smart contracts (Zohar et al., 2022). Moreover, data protection laws like the EU's General Data Protection Regulation (GDPR) add more challenges, requiring careful handling of personal data within blockchain networks. The lack of international and local standardization also acts as a barrier to adoption. Global regulatory standards must be developed to enable interoperability and compliance across jurisdictions (Gilcrest & Carvalho, 2018).

### 5.3 Economic and Financial Challenges

Economic and financial barriers stop smart contracts from being widely adopted. Implementing this technology requires big upfront investments in infrastructure (hardware and software) and high-energy consumption. These costs are a burden especially for smaller institutions. Ongoing operational costs (system maintenance and software updates) further squeeze profitability and viability. In addition, ensuring security and regulatory compliance adds more financial pressure, requiring investments in security measures to protect sensitive info and comply with laws. All challenges means we need to have a well thought out plan to ease the financial burden of smart contracts (Ahl et al., 2022).

### 5.4 Scalability and Integration Challenges with Traditional Systems

Another challenge to blockchain and smart contracts is scalability and integration with existing financial systems. Verifying transactions through consensus mechanisms requires many computational resources and slows down as the number of users increase. Research has shown that this is a big challenge for systems that need to process high volume of transactions in real time like banking and electronic payment systems (Croman et al., 2016). Unlike centralized infrastructures that can process transactions fast, blockchain is not. Integration with existing banking systems also poses challenges, often requiring big overhauls of current infrastructure to accommodate smart contracts, including changes to data processing, security frameworks and regulatory policies (Peters & Panayi, 2016). While these technical hurdles are real barriers to adoption, emerging solutions like sharing and layer-two scaling technologies can help improve smart contract efficiency and integrate without compromising decentralization and security (Zamyatin et al., 2020).

### 5.5 Key Statistics on Smart Contracts

Table 2 shows the growth of blockchain based smart contract market from 2019 to 2023, the market size is growing from \$0.65 billion in 2019 to \$2.1 billion in 2023 with a CAGR of 20-25%. The market share for Europe and Asia-Pacific is increasing while North America is decreasing. This shows the smart contract adoption is growing in these regions as more investments and broader use cases across industries.

**Table 2:** Market Size and Annual Growth Rate of Smart Contracts (Source: Market Research Future, Valuates Reports, and Global Market Estimates)

Indicator	2023	2022	2021	2020	2019
<b>Global Market Size (Billion USD)</b>	<b>2.1</b>	<b>1.75</b>	<b>1.4</b>	<b>0.78</b>	<b>0.65</b>
<b>Annual Growth Rate (CAGR)</b>	<b>0.25</b>	<b>0.23</b>	<b>0.24</b>	<b>0.22</b>	<b>0.2</b>
<b>North America</b>	<b>0.3</b>	<b>0.32</b>	<b>0.33</b>	<b>0.34</b>	<b>0.35</b>
<b>Europe</b>	<b>0.29</b>	<b>0.28</b>	<b>0.27</b>	<b>0.26</b>	<b>0.25</b>
<b>Asia-Pacific</b>	<b>0.25</b>	<b>0.24</b>	<b>0.23</b>	<b>0.22</b>	<b>0.2</b>
<b>Other</b>	<b>0.16</b>	<b>0.16</b>	<b>0.17</b>	<b>0.18</b>	<b>0.2</b>

Table (3) shows that the finance and banking sector has maintained the largest share of smart contract applications, with a significant increase from 35% in 2019 to 45% in 2023. There is a growing reliance on smart contracts to improve efficiency while reducing costs. However, the share of supply chains and logistics is drifting down, an indication of regulatory and technical issues inhibiting the adoption of this technology. On the other hand, moderate growth has been typified in the healthcare and real estate sectors as they begin gaining interest in the data security and smart contracts. The government sector has experienced a significant reduction in their share, moving from 22% to 9%. However, this data could also imply a slower adoption of this new technology.

**Table (3):** Estimates of the percentages of sectors from smart contract applications (Source: Zion Market Research, The Insight Partners, and Cognitive Market Research)

Sectors	2023	2022	2021	2020	2019
Finance & Banking	45%	42%	40%	38%	35%
Supply Chains & Retail	13%	14%	15%	16%	18%
Real Estate	11%	12%	13%	12%	10%
Health Services	12%	11%	10%	9%	8%
Gaming & Entertainment	10%	10%	9%	8%	7%
Public Sector & Government	9%	11%	13%	17%	22%

## 6. The Potential for Adopting Smart Contract Technology in the Financial and Banking Sector in Iraq

Adopting blockchain-based smart contract technology in Iraq's financial and banking sector is a big strategic step towards full digital transformation. However many challenges may hinder this process and prevent the country from keeping up with the global financial system. One of the main challenges is the lack of technological awareness among many financial and banking institutions in Iraq. A survey on private banks in Baghdad about blockchain found that these institutions lack skilled professionals to handle modern technologies. This shortage will limit their ability to adopt such systems in the short term. However, the study showed that some private banks in Baghdad are ready to adopt and implement decentralized finance technologies, although this readiness is limited due to a lack of expertise and training (Al-Khayyat & Saharwardi, 2023). As for infrastructure, Iraqi banks face a big challenge in upgrading their systems to keep up with the developments of blockchain-based smart contracts. These systems require advanced infrastructure to automate and speed up digital transactions and secure data, which requires huge investments in modern technology. One study found that many Iraqi banks still use old systems, so they cannot handle the volume of data and transactions that blockchain technology will require (Jaber, 2022). Another big challenge in adopting smart contracts in Iraq is the absence of suitable legal and regulatory frameworks to support these technologies. This is one of the main factors that will hinder the implementation of smart contract technology in the financial and banking systems, as there is no clear legal framework to allow the use of digital currencies or smart contracts. Moreover, the Iraqi Central Bank has criminalized the use of digital currencies and decentralized finance tools that are not under its control, citing regulatory oversight, legal issues and money laundering and terrorism financing concerns (Iraqi Central Bank, 2022). Financial and banking experts in Iraq say that attention should be given to keeping up with modern technologies especially decentralized finance technologies like blockchain to enhance transparency and operational efficiency in the Iraqi financial system. This will be especially useful in areas like auditing, financial reporting and automating banking operations to reduce financial risks and comply with regulations and laws (Zubair & Dhuon, 2023).

## 7. Conclusion and Recommendations

### 7.1 Conclusion:

- A) Smart contracts are a game changer for financial and banking institutions. They automate processes, increase transparency and reduce human intervention, which means cost reduction and more reliable financial systems.
- B) The current regulatory and legal framework in Iraq is not supportive for decentralized digital systems in financial and banking sector. The existing laws do not meet the requirements of blockchain and smart contracts.
- C) Iraq needs advanced technological environment to support the infrastructure of decentralized digital systems. Financial and banking institutions do not have sophisticated information systems that are compatible with blockchain technology so they cannot benefit from smart contracts in financial automation and data management applications.

- D) Iraq has challenges in technological awareness and the skills of its workforce in financial and banking sector. Lack of qualified personnel to manage and operate smart contracts systems is a major obstacle to adopt this technology.
- E) Weak security and cyber threats is a major challenge in smart contracts, so there is a need for national cybersecurity strategies to protect digital data and secure financial and banking operations.

## 7.2 Recommendations:

- A) To use smart contract technology in financial and banking institutions to improve performance, transparency and operational efficiency. Focus on automation and reduce human intervention to increase financial systems reliability and accuracy.
- B) The legal and regulatory framework in Iraq should be updated to match decentralized digital technologies like smart contracts. This will protect financial institutions and citizens and create a legislative environment for these technologies.
- C) Iraq should develop its technological and digital infrastructure; upgrade the information systems of financial institutions to be compatible with blockchain technology. This will support smart contracts and enable them to automate and manage data.
- D) Intensive training and capacity building programs should be conducted to upgrade the skills of the workforce in financial and banking sector in Iraq, especially in managing and operating decentralized digital systems. This will speed up the adoption of these technologies in financial sector.
- E) National cybersecurity strategies should be established to address cyber threats, focus on developing a strong security system to protect digital data and secure financial operations.

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