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A Survey On Smart Contract Platforms And Features

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Abstract:

In the recent years with the development of smart contracts, agreements may now be executed decentralised and automatically without the use of middlemen. To assist the implementation and execution of smart contracts, many smart contract platforms have been created. This survey report offers a thorough examination of numerous smart contract systems and their unique characteristics. We outline the essential traits, features, and capabilities of various platforms while highlighting their advantages and disadvantages. In addition, we look at the fundamental attributes provided by smart contract platforms, such as programmability, interoperability, scalability, and security. We hope that this poll will help academics, developers, and decision-makers better understand the ecosystem of smart contract platforms and choose the one that best meets their individual needs.

Keywords. Smart Contract, features, platform, automation

I. Introduction

The notion of smart contracts, which are self-executing agreements with the terms of the contract explicitly put into code, has emerged with the emergence of blockchain technology. Smart contracts do away with the need for middlemen and offer efficient, secure, and transparent transaction execution across a range of sectors. As a result, many platforms for smart contracts have been created to make it easier to implement and use smart contracts [1][2].

This study aims to examine the landscape of smart contract platforms and their distinctive characteristics. This research intends to aid academics, developers, and decision-makers in understanding the strengths and limits of various smart contract platforms by offering an overview of various platforms and their capabilities [3][4]. The survey will provide stakeholders the information they need to choose the best platform for their unique needs.

II. Smart Contracts: Overview and Concepts

a. Definition and Characteristics:

Smart contracts are self-executing contracts with the terms and conditions directly written into code. They automatically execute the agreed-upon actions when predetermined conditions are met. These contracts operate on decentralized blockchain networks, ensuring transparency, immutability, and security [5].

Key characteristics of smart contracts include:

a. Automation: Smart contracts eliminate the need for intermediaries by automatically executing actions based on predefined conditions.

b. Transparency: The code and execution of smart contracts are recorded on a blockchain, providing transparency to all participating parties.

c. Immutability: Once deployed on a blockchain, smart contracts cannot be altered, ensuring that the agreed-upon terms and conditions remain unchanged.

d. Decentralization: Smart contracts operate on decentralized blockchain networks, removing the reliance on a single centralized authority.

b. Benefits and Challenges:

Smart contracts offer several benefits, including:

a. Efficiency: Automation of contract execution reduces manual effort and speeds up processes.

b. Transparency: The transparent nature of smart contracts enhances trust among parties involved.

c. Security: The use of cryptographic techniques and blockchain's immutability ensures the integrity and security of smart contracts.

d. Cost savings: Smart contracts eliminate the need for intermediaries, reducing transaction costs.

Despite the advantages, smart contracts also face challenges:

a. Code vulnerabilities: Errors or vulnerabilities in smart contract code can lead to unexpected outcomes and security breaches.

b. Scalability: The scalability of smart contract platforms is crucial to handle a high volume of transactions efficiently.

c. Legal and regulatory considerations: Integrating smart contracts into existing legal frameworks poses challenges due to varying legal interpretations and regulatory compliance.

c. Use Cases:

Smart contracts find applications in various industries, including:

a. Financial Services: Smart contracts enable secure and efficient execution of financial transactions, such as lending, asset management, and insurance.

b. Supply Chain Management: Smart contracts improve transparency, traceability, and efficiency in supply chain processes, including tracking and verifying product provenance.

c. Real Estate: Smart contracts can streamline property transactions, automate rental agreements, and ensure transparent and secure property ownership.

d. Healthcare: Smart contracts facilitate secure sharing and management of patient health records and automate processes related to insurance claims and payment settlements.

e. Governance and Voting: Smart contracts can enhance the transparency and integrity of voting systems, enabling secure and decentralized governance processes.

f. Intellectual Property: Smart contracts enable artists and creators to protect their intellectual property rights and automate royalty payments.

g. Energy Trading: Smart contracts facilitate peer-to-peer energy trading and enable efficient management of energy grids.

III. Smart Contract Platforms

This section provides a detailed survey of various smart contract platforms, highlighting their key characteristics, functionalities, and capabilities. The following platforms are included in the survey:

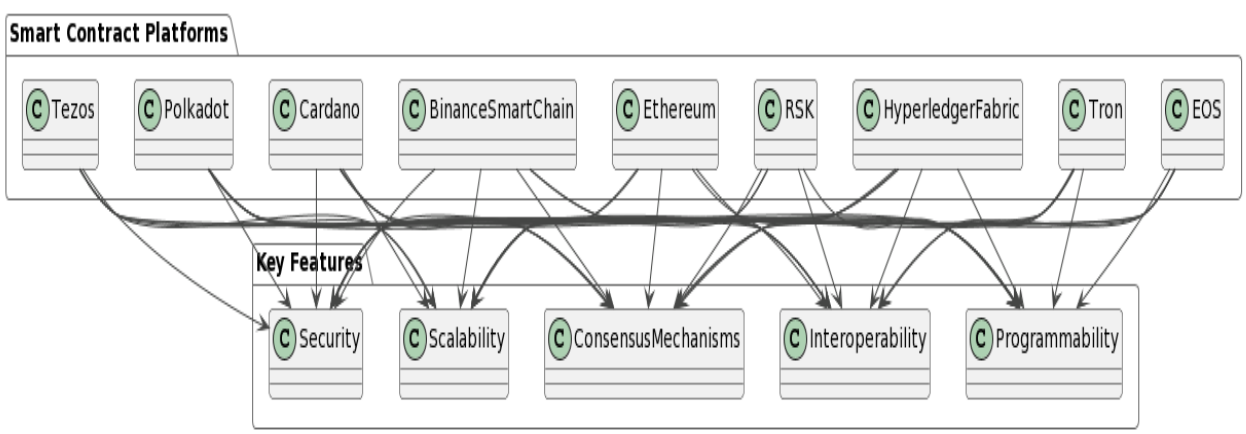

Figure 1. Smart Contract Platforms

3.1 Ethereum:

Ethereum is one of the most popular and widely adopted smart contract platforms. It introduced the concept of smart contracts and offers a robust programming language called Solidity. Ethereum's platform supports the deployment of decentralized applications (DApps) and enables the creation and execution of complex smart contracts. It utilizes the proof-of-work (PoW) consensus mechanism.

3.2 Binance Smart Chain (BSC):

Binance Smart Chain is a blockchain platform compatible with the Ethereum Virtual Machine (EVM), allowing seamless migration of Ethereum-based applications. BSC focuses on high throughput and low transaction fees. It implements a proof-of-staked-authority (PoSA) consensus mechanism, combining proof-of-stake (PoS) and proof-of-authority (PoA) elements.

3.3 Cardano:

Cardano is a blockchain platform that aims to provide a secure and scalable infrastructure for the execution of smart contracts. It utilizes a unique proof-of-stake (PoS) consensus algorithm called Ouroboros, which ensures security while minimizing energy consumption. Cardano offers a multi-layered architecture that separates the settlement and computation layers, enhancing scalability.

3.4 Polkadot:

Polkadot is a multi-chain platform that enables interoperability between different blockchains. It provides a scalable and secure environment for deploying and executing smart contracts. Polkadot utilizes a shared security model and employs a nominated proof-of-stake (NPoS) consensus algorithm. Its architecture allows independent blockchains to communicate and share data.

3.5 Tezos:

Tezos is a self-amending blockchain platform that focuses on governance and formal verification of smart contracts. It employs a liquid proof-of-stake (LPoS) consensus mechanism, where token holders can participate in the consensus process. Tezos supports smart contract development in the Michelson programming language and emphasizes security and upgradability.

3.6 EOS:

EOS is a blockchain platform designed for high-performance decentralized applications. It offers a user-friendly environment for smart contract development and execution. EOS utilizes a delegated proof-of-stake (DPoS) consensus algorithm, where a limited number of elected block producers validate transactions. It aims to achieve scalability and low latency.

3.7 Tron:

Tron is a blockchain platform focused on decentralized content sharing and entertainment applications. It supports the deployment and execution of smart contracts written in the Solidity programming language. Tron utilizes a delegated proof-of-stake (DPoS) consensus mechanism, allowing stakeholders to vote for super representatives who validate transactions.

3.8 Hyperledger Fabric:

Hyperledger Fabric is a permissioned blockchain platform designed for enterprise use cases. It offers a modular architecture that allows organizations to create and customize smart contract networks. Hyperledger Fabric supports various consensus mechanisms and provides privacy and confidentiality features suitable for enterprise applications.

3.9 RSK:

RSK (Rootstock) is a smart contract platform that operates as a sidechain to the Bitcoin blockchain. It brings smart contract capabilities and compatibility with the Ethereum Virtual Machine (EVM) to the Bitcoin ecosystem. RSK utilizes a merge-mining consensus mechanism, leveraging Bitcoin's hash power for security.

3.10 Comparison and Evaluation Metrics:

In this survey, the smart contract platforms will be compared and evaluated based on various metrics, including scalability, security, programmability, interoperability, and consensus mechanisms. These metrics provide insights into the strengths and limitations of each platform and aid in understanding their suitability for different use cases.

Platform	**Scalability**	**Security**	**Programmability**	**Interoperability**	**Consensus Mechanisms**

Ethereum	High	High	Turing Complete	Limited	Proof of Work
Binance Smart Chain	High	Medium	EVM-Compatible	Limited	Proof of Staked BNB
Cardano	High	High	Plutus	Limited	Ouroboros
Polkadot	High	High	Substrate	High	Nominated Proof of Stake
Tezos	High	High	Michelson	Limited	Liquid Proof of Stake
EOS	High	High	C++	Limited	Delegated Proof of Stake
Tron	High	Medium	Solidity	Limited	Delegated Proof of Stake

Hyperledger Fabric	Medium	High	Chaincode	Limited	Practical Byzantine Fault Tolerance
RSK	Medium	High	Solidity	Limited	Merge-Mined Proof of Work

Table 1. smart contract platforms and their features

IV. Key Features of Smart Contract Platforms

This section focuses on the key features offered by smart contract platforms, which play a crucial role in determining their capabilities and suitability for different applications. The following features are essential considerations when evaluating smart contract platforms:

4.1 Scalability:

Scalability refers to a platform's ability to handle a high volume of transactions and support a growing user base. Smart contract platforms employ various techniques to enhance scalability, such as sharding, layer 2 solutions, or adopting consensus algorithms that improve transaction throughput. Evaluating a platform's scalability is crucial to ensure it can handle the anticipated workload efficiently.

4.2 Security:

Security is a critical aspect of smart contract platforms, as vulnerabilities in smart contract code can lead to significant financial losses or exploits. Platforms implement security measures such as code auditing, formal verification, and bug bounties to minimize risks. Additionally, the consensus mechanism and underlying blockchain infrastructure contribute to the overall security of the platform.

4.3 Programmability:

The programmability of a smart contract platform determines the flexibility and capabilities of the smart contracts developed on it. Platforms may offer different programming languages, development frameworks, and tools to facilitate smart contract creation and execution. Robust and expressive programming languages allow developers to build complex and sophisticated applications.

4.4 Interoperability:

Interoperability is the ability of smart contract platforms to communicate and share data with other platforms or blockchains. It enables the seamless transfer of assets, information, and functionality across different networks. Interoperable platforms use standardized protocols, cross-chain communication mechanisms, or bridges to ensure compatibility and enable collaboration between disparate systems.

4.5 Consensus Mechanisms:

Consensus mechanisms define how transactions are validated and added to the blockchain. Different smart contract platforms employ various consensus algorithms, such as proof-of-work (PoW), proof-of-stake (PoS), delegated proof-of-stake (DPoS), or practical Byzantine fault tolerance (PBFT). The consensus mechanism affects factors like security, decentralization, scalability, and energy efficiency.

V. Survey Methodology

This section outlines the methodology employed in conducting the survey on smart contract platforms. It describes the data collection process, evaluation criteria, and data analysis techniques used to assess and compare the platforms.

5.1 Data Collection:

The survey involved gathering data from various sources, including research papers, technical documentation, whitepapers, official websites, developer resources, and community forums. It aimed to ensure a comprehensive and up-to-date understanding of each smart contract platform.

5.2 Evaluation Criteria:

To evaluate and compare the smart contract platforms, a set of criteria and metrics were established. These criteria encompassed the key features mentioned in Section 4, such as scalability, security, programmability, interoperability, and consensus mechanisms. Each criterion was assigned specific metrics or benchmarks to assess the performance and capabilities of the platforms in that particular area.

Additionally, the evaluation criteria considered factors such as adoption rate, community support, developer ecosystem, documentation quality, and governance models. These factors provide insights into the platform's maturity, community engagement, and long-term sustainability.

5.3 Data Analysis:

The collected data was analyzed systematically to evaluate the performance and features of each smart contract platform. The analysis involved a qualitative assessment of each platform based on the established evaluation criteria. The strengths, limitations, and unique characteristics of each platform were identified and documented.

Comparative analysis techniques, such as creating comparison matrices and scoring systems, were employed to facilitate the assessment and comparison of the platforms. The analysis aimed to provide an objective evaluation of the platforms' capabilities and to identify the platforms that excel in specific areas.

Throughout the analysis, any limitations or biases in the data collection process or evaluation criteria were acknowledged and addressed to ensure the validity and reliability of the survey findings.

VI. Comparative Analysis of Smart Contract Platforms

This section presents a comparative analysis of the surveyed smart contract platforms based on the evaluation criteria established in Section 5. The analysis highlights the strengths and limitations of each platform, allowing stakeholders to make informed decisions when selecting the most suitable platform for their specific needs.

6.1 Scalability:

In terms of scalability, Ethereum faces challenges due to its current proof-of-work (PoW) consensus mechanism, resulting in limited transaction throughput and higher fees during peak demand. However, Ethereum 2.0 aims to address these scalability issues through the implementation of a proof-of-stake (PoS) consensus mechanism and the introduction of shard chains. Binance Smart Chain (BSC) offers higher scalability and lower fees by sacrificing some decentralization aspects. Cardano and Polkadot adopt innovative approaches to scalability, focusing on layering and interoperability between multiple chains. Tezos, EOS, and Tron also emphasize scalability to varying degrees in their design.

6.2 Security:

Ethereum has established a strong track record in terms of security, but the presence of vulnerabilities in smart contract code remains a challenge. Platforms like Cardano and Tezos prioritize formal verification techniques to enhance security. Binance Smart Chain and Tron inherit some security aspects from their interoperability with Ethereum, but they may be exposed to additional risks due to their consensus mechanisms. Hyperledger Fabric, being a permissioned platform, offers enhanced security features suitable for enterprise applications.

6.3 Programmability:

Ethereum, being the pioneer, has a mature ecosystem with extensive developer tools, libraries, and a wide range of supported programming languages. BSC inherits compatibility with Ethereum, while Cardano and Tezos offer their programming languages and frameworks. EOS and Tron provide developer-friendly environments with support for Solidity. Hyperledger Fabric focuses on supporting various programming languages for enterprise use cases.

6.4 Interoperability:

Polkadot stands out in terms of interoperability, offering a framework for connecting different blockchains. Ethereum, BSC, Cardano, and Tezos have varying degrees of compatibility with Ethereum, enabling seamless migration of existing applications. Tron and EOS are more self-contained platforms, primarily focusing on their own ecosystems. Hyperledger Fabric offers interoperability features through its modular architecture.

6.5 Consensus Mechanisms:

Each platform adopts a different consensus mechanism. Ethereum and BSC currently use PoW and PoSA, respectively, with Ethereum transitioning to PoS in Ethereum 2.0. Cardano utilizes the Ouroboros PoS algorithm, which aims to achieve security and scalability. Tezos uses LPoS, ensuring stakeholder participation in consensus. EOS and Tron employ DPoS, emphasizing speed and efficiency. Hyperledger Fabric supports various consensus mechanisms, including practical Byzantine fault tolerance (PBFT).

The Ethereum remains a dominant player, with a mature ecosystem and widespread adoption. Binance Smart Chain offers scalability and compatibility with Ethereum. Cardano and Polkadot focus on scalability and interoperability. Tezos emphasizes security and upgradability. EOS and Tron target decentralized applications in specific domains. Hyperledger Fabric caters to enterprise use cases with its permissioned architecture. RSK provides smart contract capabilities within the Bitcoin ecosystem.

The choice of the most suitable smart contract platform depends on the specific requirements, priorities, and trade-offs desired by stakeholders in terms of scalability, security, programmability, interoperability, and consensus mechanisms.

VII. Conclusion and Future Directions

This section concludes the survey on smart contract platforms and their features. It summarizes the key findings and implications of the research and suggests potential future directions for smart contract technology.

7.1 Summary of Findings:

The survey presented an overview of smart contracts, their characteristics, and the benefits they offer. It surveyed popular smart contract platforms such as Ethereum, Binance Smart Chain, Cardano, Polkadot, Tezos, EOS, Tron, Hyperledger Fabric, and RSK. Each platform was evaluated based on key features such as scalability, security, programmability, interoperability, and consensus mechanisms.

The comparative analysis highlighted the strengths and limitations of each platform. Ethereum stood out as the leading platform with a mature ecosystem and widespread adoption. Other platforms offered unique features such as scalability (BSC, Cardano, Polkadot), security (Tezos, Cardano), developer-friendly environments (EOS, Tron), enterprise support (Hyperledger Fabric), and compatibility with Bitcoin (RSK).

7.2 Implications:

Smart contract platforms have revolutionized various industries by enabling secure, transparent, and efficient execution of agreements. They have the potential to streamline processes, reduce costs, and enhance trust among participants. The findings of this survey can guide stakeholders in selecting the most suitable platform for their specific use cases.

It is essential to consider factors such as scalability, security, programmability, interoperability, and consensus mechanisms when evaluating and implementing smart contract solutions. Stakeholders should also stay informed about technological advancements, upgrades, and new platforms entering the market to leverage the latest features and improvements.

7.3 Future Directions:

Smart contract technology continues to evolve, and future research and development can focus on the following areas:

a. Scalability Solutions: Further research and innovation are needed to address the scalability limitations of existing platforms. Approaches such as sharding, layer 2 solutions, and improved consensus algorithms can enhance transaction throughput and reduce fees.

b. Security Enhancements: Continued efforts in code auditing, formal verification, and bug bounty programs can help minimize vulnerabilities in smart contract code. New security mechanisms and techniques can be explored to ensure robustness and protect against attacks.

c. Interoperability Standards: Developing standardized protocols and frameworks for seamless interoperability between different smart contract platforms can enhance collaboration and facilitate the exchange of assets and information across multiple networks.

d. Privacy and Confidentiality: Enhancing privacy features in smart contract platforms can address concerns regarding data confidentiality. Research can focus on techniques such as zero-knowledge proofs and secure multiparty computation to enable private and secure transactions.

e. Governance Models: Exploring novel governance models that ensure transparency, inclusivity, and decentralized decision-making can contribute to the long-term sustainability and governance of smart contract platforms.

f. Integration with Real-World Data: Further integration of smart contracts with real-world data sources can enhance their functionality and enable the execution of more complex and dynamic agreements.

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