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Smart Contracts in Built Environment - Real Estate Sector

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Abstract*— India's rapid urbanization and ambitious infrastructure projects require transparent and effective contracting mechanisms in the built environment. Traditional paper contracts are slow and prone to disputes due to incomplete records. This study examines the state of smart contracts using blockchain technology in India, to facilitate efficient, transparent, and secure contract management, benefiting the built environment as part of the country's urban development efforts and the transformative potential of smart contracts. Smart contracts automate, improve security, and ensure transparency. They are autonomous and self-executing, minimizing errors and fraud risks. A comprehensive review of the current legal and regulatory frameworks governing contracts in India's built environment will be undertaken. This analysis seeks to decipher existing structures and their adaptability to the innovative model of smart contracts. The aim is to comprehensively understand smart contract adoption in India, considering the legal framework, standards, and adoption roadmap. This study examines the state of smart contracts in India, to facilitate efficient, transparent, and secure contract management, benefiting the built environment as part of the country's urban development. Considering the scope and limitations of this study, it is important to note that this study primarily focuses on the built environment sector in India. This industry orientation allows you to delve deeper into the specific subtleties and nuances of this field. However, this limited range may lead to limitations in the diversity of sample populations available for comprehensive data analysis. Additionally, due to geographical and industry constraints, the study recognizes potential limitations in its degree of generalization beyond the research context. Considering the transformative potential of smart contracts, this research will foster progress that will promote transparency, efficiency, and effectiveness in contracting practices and benefit stakeholders operating in India's built environment.

***Index Terms*— Adoption, Blockchain, Built Environment, Legal and Regulatory, Security, Smart Contracts.**

I. INTRODUCTION

The emergence of smart contracts has brought about a new platform that can replace traditional contracts. Smart contracts are characterized by full automation, enhanced security codes, and transparency between parties. These self-executing and self-enforcing encoded software contracts minimize the risks of errors and fraud during execution. This paper embarks on a journey to explore the existing contract framework, comparing traditional contracts with smart contracts. Furthermore, it aims to shed light on the adoption of smart contracts in the built environment sector in India. This paper examines the legal, regulatory, and technological factors that are shaping this transformative landscape, providing valuable insight into this novel development.

II. SMART CONTRACTS

Smart contracts are contracts programmed with the blockchain that automatically executes upon the fulfillment of certain conditions. This removes the requirement of a third-party intermediary for overseeing the transaction in real time. (Nawari and Ravindran)

Smart contracts have the potential to revolutionize the construction industry by streamlining processes, reducing disputes, and increasing transparency and efficiency in various aspects of construction projects.

Smart contracts have the potential to significantly improve efficiency, transparency, and collaboration in the construction industry, leading to cost savings, reduced project delays, and improved project outcomes.

Distribution – information is recorded by distributing it among several nodes to ensure IT security and system resilience.

Features of Smart contracts

- Traceability – each element (i.e., transaction) on the register is traceable in every respect and can be mapped back to its precise origin.
- Disintermediation – blockchain platforms allow the management of transactions without intermediaries, in other words, without the presence of trusted central bodies.
- Transparency – the content of the register is transparent and visible to everyone (in the public blockchain), as well as easily accessible and verifiable.
- Immutability – once written into the register, the data cannot be changed without the network's consent.
- Trust – this is built by the P2P network via the consensus mechanism, with no need for intermediaries, even though there is no trust among the parties involved. (Ciotta et al.)
- Opportunity to program transactions – it is possible to schedule actions that take place when certain conditions occur on the blockchain.

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Blockchain technology

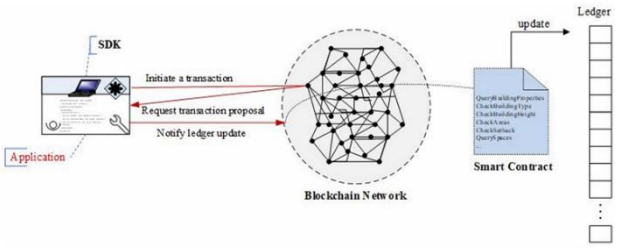

Figure 1 The concept of a smart contract in a blockchain network (Nawari and Ravindran)

Blockchain technology belongs to the wider digital ledger family, of which there are three fundamental types: centralized, decentralized (based on hubs), and distributed. The blockchain approach belongs to the last of these, i.e., distributed ledger technology (DLT). This is a type of data structure that exists across multiple computing devices, called nodes, which are generally spread over locations or regions throughout the internet (IP/TCP), and acts as the base technology for information sharing. (Ciotta et al.)

How blockchain application works

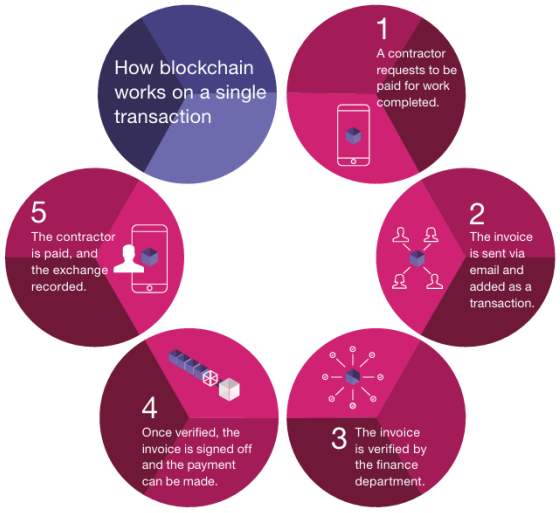

Figure 2 How blockchain based application works (Blockchain and the Built Environment_Arup)

III. GAPS FOUND BETWEEN TRADITIONAL CONTRACTS AND SMART CONTRACTS

Manual intervention

The traditional form of contract has complexity which incorporates processes like drafting, and verification execution which paves the way to time delays and errors in the cycle, which can result in inefficiencies that create a great impact on the organization. Essentially, smart contracts do not rely on human intervention, and their implementation is guided and overseen by other nodes in the blockchain network. Therefore, once the contract is triggered, the scripted contract self-executes ("Smart Contracts Implementation, Applications, Benefits, and Limitations")

Intermediaries

The involvement of intermediaries like agents, lawyers, and notaries plays an important role in traditional contracts they facilitate processes like negotiation, and the verification process, ensuring legal compliances which adds time to the process and cost overheads.

The implementation of smart contracts through blockchain technology cuts the need for a middleman, such as legal personnel. This, in turn, aids in reducing the overall organizational costs and maximizing the profit margins of an organization. ("Smart Contracts Implementation, Applications, Benefits, and Limitations")

Storage issues

This faces storage issues because of the reliance on physical hardcopy documents which leads to storage constraints, damages, loss, and susceptibility where every document should be scanned which results in retrieval and organization in transformation for digital forms. (*Electronic Contracts vs Traditional: What Is E-Contract - Pandadoc*)

Privacy and complexity

In traditional contracts, limited services and complexity pose challenges for legal and regulatory compliance, whereas smart contracts offer independent auditing methods ensuring reliability and security through automated processes. Privacy considerations in traditional contracts rely heavily on manual control, potentially leading to privacy concerns due to human error or malicious intent. Smart contracts address this with built-in privacy controls and codes, restricting access to enrolled parties only, enhancing confidentiality, and reducing the risk of unauthorized tampering or sharing of sensitive information.

Smart Contracts are much more resistant to tampering and hacking than other applications thanks to the cryptography feature of the blockchain.(Li et al.) This technology entails high encryption of data and the use of both private and public keys for reading the transactions in each blockchain, as well as executing any transaction. ("Smart Contracts Implementation, Applications, Benefits, and Limitations")

Format of contracts

Smart contracts can execute predefined conditions automatically, streamlining real estate transactions without manual intervention, thus offering quicker and more efficient processes. Conversely, traditional contracts often necessitate manual editing, requiring extensive verification and revisions to the entire draft, resulting in time-consuming processes and increased administrative burden.

Cost

Traditional contracts incur significant costs in resources due to the involvement of intermediaries, material expenses, and inefficiencies in the process but smart contracts can offer potential cost savings by reducing material costs minimizing intermediaries, and streamlining the overall transactions by

automation and digitalization, leading to better efficiency and resource optimization. In the recent world that has seen a vast technological revolution, the success of the business enterprises is vested in their ability to keep tabs with the prevailing technologies and adopt ensures and techniques that otherwise increase the employees' productivity and performance.("Smart Contracts Implementation, Applications, Benefits, and Limitations") Smart contracts provide a mechanism for conducting transactions directly through cryptocurrency, thereby minimizing the need for intermediaries in the traditional banking system. This approach to financing may potentially eliminate the intervention of financial institutions and streamline the funding process. The elimination of institutions can reduce transaction costs, speed and enhance reliability.

Transparency

In traditional contracts, record-keeping and tracking of changes are difficult, and missing records may lead to disputes between the parties, Additionally, record-keeping and history tracking may be cumbersome. The implementation of smart contracts puts every detail of the contract into the light. Unlike in the traditional contract where the organization would have to use the legal framework as the intermediary, in the virtual world all that is needed is other nodes in the network, who are tasked with the responsibility of ensuring that each transaction about the contract is accurate and valid("Smart Contracts Implementation, Applications, Benefits, and Limitations") On the other hand, smart contracts offer transparent transactions and ensure that data cannot be tampered with or deleted, resulting in good tracking of changes and record-keeping. This reduces the likelihood of disputes. Smart contracts implemented through blockchain technology entail the use decentralized network made of non-trusting parties [40]. The fact that the parties in the network are non-trusting makes them keep check of one another to ensure each transaction is carried out effectively, and that there is a uniform worldview of the status of all the transactions. ("Smart Contracts Implementation, Applications, Benefits, and Limitations")

Dynamic Environment

Traditional contracts are inflexible, which is difficult to adapt to any changes in a dynamic market. They often require manual revisions and a lengthy legal process to accommodate modifications. On the other hand, smart contracts offer several benefits as they allow for automated updates and dynamic execution of predefined conditions. This means that they can respond to changing circumstances in real time, increasing efficiency and agility in India's evolving business landscape.

Scalability

Traditional contracts may struggle to scale a high volume of transactions and complex agreements due to resource limitations and manual processes, but smart contracts have more scalability, with the use of blockchain technology for automation, and can handle large transactions without compromising the need. (Li et al.)

Operational efficiency

Traditional contracts often manual handling which may result in challenges for both parties located remotely or in distinct locations. Smart contracts, being digital and online offers remote access and execution, enabling the parties to engage in transactions from everywhere and anywhere with good network connectivity which increases the operational ability. (Ye et al.)

Global network

Traditional contracts may face challenges in cross-border transactions due to legal, linguistic, and jurisdictional differences across the world, which international transactions. Adding to this the lengthy negotiation and documentation processes can lead to inefficiencies in executing global agreements.

Smart contracts can leverage decentralized blockchain technology accessing geographical boundaries, which enables real-time transactions without any intermediaries. Smart contracts provide security, and transparency, and reduce transaction costs and fees associated with cross-border transactions. Moreover, smart contracts embed regulatory compliance rules, simplifying the navigation of complex regulatory frameworks across jurisdictions.

Technology has a globalized span, connecting users from every corner of the globe and allowing them to carry out cryptograph-enabled, data-secure, decentralized transactions. The implications of the openness of this system of transactions for both individual consumers and businesses are substantial. Such transactions are carried out across many different types of markets and platforms. (Ghosh)

Managing Diverse Data Formats

Handling of various formats of documents and files in traditional contracts involves manual processes like printing, signing, scanning, recording, and storing which lead to inefficiencies, delays, and the risk of errors or loss. Integrating diverse data, such as photos, videos, or IoT device data, into traditional contracts may require additional manual effort and verification.

Smart contracts have programmable capabilities to handle diverse data formats within the blockchain ecosystem, it can access, verify, and process various types of data, including agreements, plans, multimedia files, and IoT device readings, in a secure and automated manner. This integration enhances transparency, accuracy, and efficiency in contract execution and performance.

Insurance

Insurance companies can use BC to automate insurance claims, verification of qualifying criteria and execution of

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privileges. This would be advantageous in saving cost by minimizing the workload by insurance agents who are tasked with manually N.O. Nawari and S. BC would also benefit clients by ensuring efficient payouts through instantaneous transactions and providing comparisons between policies for better-informed decision-making. (Nawari and Ravindran)

IV. METHODOLOGY

1. Introduction to blockchain and smart contract technologies
2. Gaps found in traditional contracts and smart contracts in the real estate environment.
3. Survey with professionals.
4. Data cleansing
5. Qualitative Analysis and present the findings.

V. RESEARCH FINDINGS

A survey was conducted among experts from various sectors of the industry, including legal firms, real estate agencies, and financial institutions. The survey aimed to gather insights on the knowledge of smart contracts among the participants. A total of 31 responses were received, out of which 16 respondents reported being aware of the concept of smart contracts. The perspectives of these informed respondents were identified and analyzed.

The results of the survey indicate that a significant proportion of experts in the industry are yet to gain familiarity with the concept of smart contracts. However, the perspectives of the respondents who do know about smart contracts provided valuable insights into the potential benefits and drawbacks of the technology.

Effectiveness of existing traditional contract

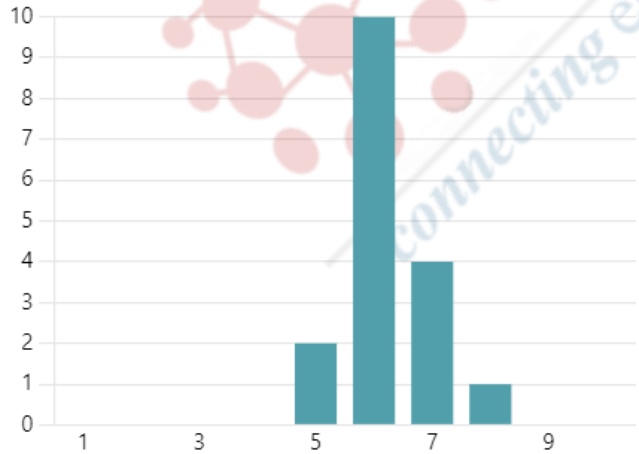

Figure 3 Effectiveness of the current traditional form of contracts.

Based on the survey, respondents were asked to rate the current effectiveness of the current form of contracts on a scale of 10. The findings indicate an average rating of 6.24 has been found. signaling a notable dissatisfaction and highlighting substantial areas for enhancement in contract structures.

Difficulties faced in traditional form of contracts

The stakeholders proposed the following issues and their synonyms based on their perspective of difficulties encountered in the traditional form of contracts.

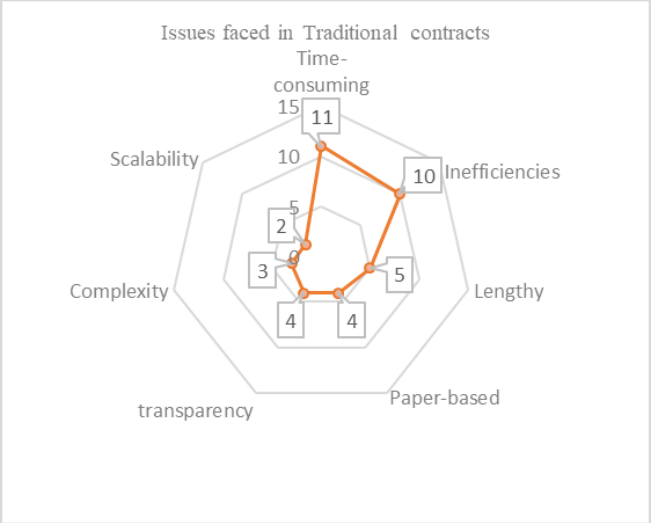

Figure 4 Issues faced in traditional contracts

Time constraint: Time is taken for the drafting, revising, and executing the contract document which delays the process.

Complexity The drafting of traditional contracts is complex and updating them is difficult when changes are implemented. (*Electronic Contracts vs Traditional: What Is E-Contract - Pandadoc*)

Inefficiency: inefficiency due to ambiguity in language, frequent disputes over interpretation, and lengthy negotiation processes, which contribute to delays, disputes, and increased costs. (Nanayakkara et al.)

Transparency: That is caused by complex contract terms, and it is difficult to track changes and pave the way for accountability. This is a negative impact on the upstream members in the real estate.

Storage issue: This faces storage issues because of the reliance on physical hardcopy documents which leads to storage constraints, damages, loss, and susceptibility where every document should be scanned which results in retrieval and ohrganization in transformation for digital forms. (*Electronic Contracts vs Traditional: What Is E-Contract - Pandadoc*)

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When can we expect smart contracts in India

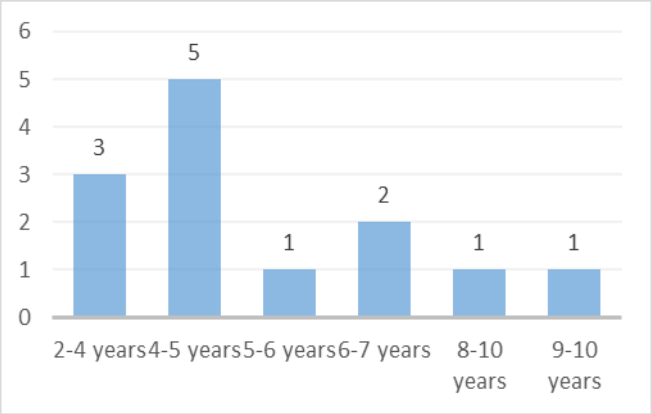

Figure 5 Expectations of smart contracts in coming years.

Based on the analysis of the survey collected from experts, most of the respondents expect smart contracts to achieve widespread acceptance within the next 4-5 years.

Appealing factors to use smart contracts in the real estate-built environment

Smart contracts are a revolutionary advancement in business operations that provide transparency and tamper-proof record-keeping while reducing disputes and errors and eliminating intermediaries. This efficient approach ensures robust data security, accelerates processes, and increases transaction reliability. Smart contracts streamline operations by eliminating manual intervention, reducing costs, and promoting transparency, which ultimately results in a new era of reliability and security in contract management. This paves the way for smooth and secure business transactions across various industries.

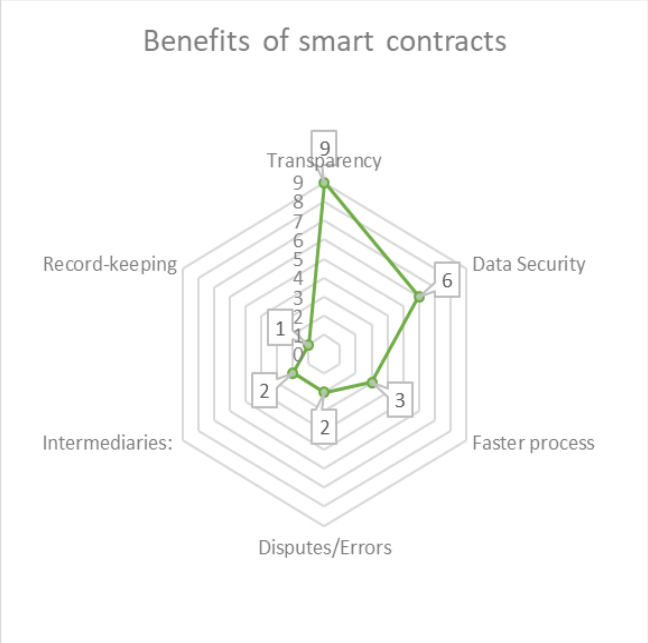

Figure 6 Benefits of smart contracts.

Promotion of the mainstream adoption of smart contracts

Awareness: Organization awareness campaigns and workshops for the understanding of smart contracts and their advantages.

Education: Implement focused training courses, fast-track courses, and seminars for the real estate industry to improve knowledge and expertise about using smart contracts for property management and transactions.

Regulatory clarity: Collaborating with regulatory organizations to create legal frameworks that are transparent, accommodating, and that answer issues while offering instructions for the application of smart contracts. Advocating for regulatory change and standardization to foster the use while integrating smart contracts into current legal systems.

Collaboration: Collaboration by together industry gatherings, institutions, and conferences to highlight successful use cases and case studies of smart contract implementation in real estate transactions, encouraging stakeholders to embrace this technology for increased security and efficiency.

Incentives: Offering tax waivers, subsidies etc. for people who adopt smart contracts.

Figure 7 Mainstreaming of adoption of smart contracts.

Integration of smart contracts with existing system

According to the respondents, the integration of smart contracts among the stakeholders and the existing system is expected to be done well, with an average rating of 8.35. They also noted that the adoption of smart contracts is expected to be efficient shortly.*(Electronic Contracts vs Traditional: What Is E-Contract - Pandadoc*)

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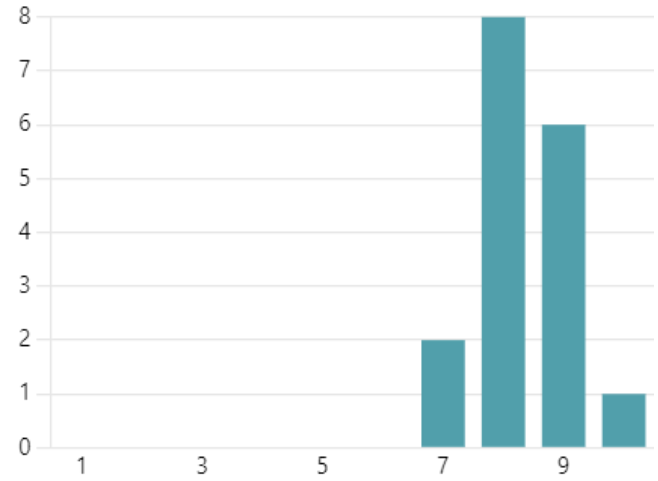

Government incentives for the adoption of smart contracts

Based on the respondent's input, the government can provide incentives such as tax waivers to those who adopt smart contracts in both industrial and consumer sectors. Additionally, subsidies and funding can be offered to encourage the widespread adoption of smart contracts. Investing in skill development and education programs can help to create a proficient workforce capable of effectively leveraging smart contracts and advancing digital transformation initiatives.

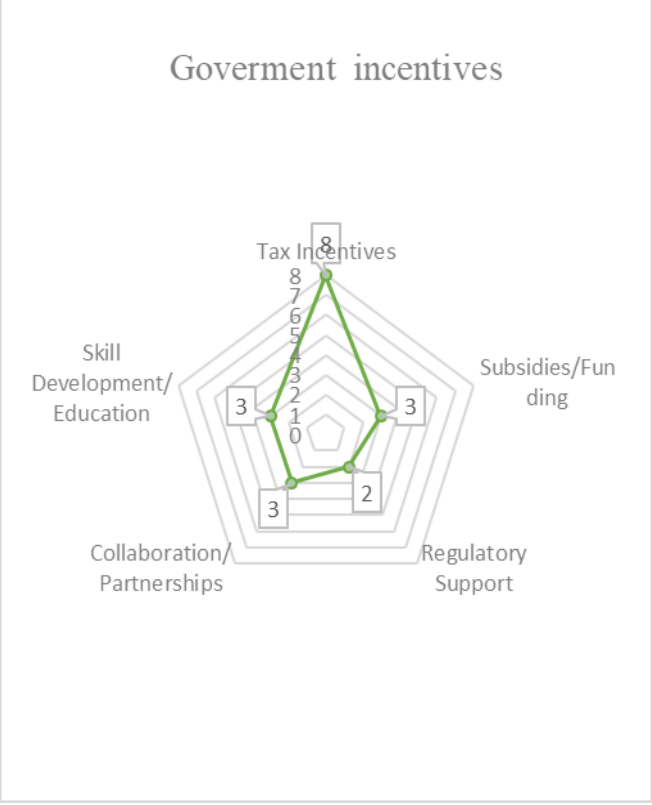

Figure 8 Incentives from Government

Barriers to adoption

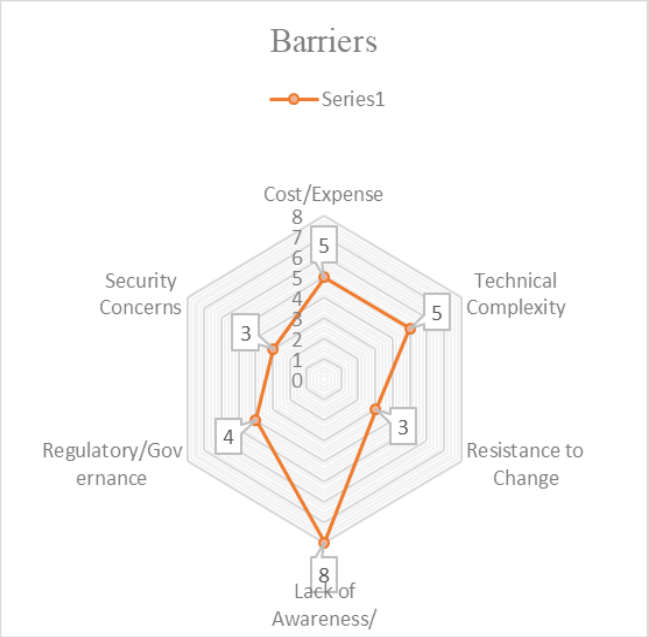

Figure 9 Barriers for adoption.

It is important to consider several factors when implementing smart contracts. These include the initial cost of installation, the technical complexity that consumers may face, resistance to change from professionals who are accustomed to traditional methods, potential security risks due to a lack of knowledge about data privacy and the existence of smart contracts, and the need for proper regulatory compliance.

People who get impacted by the adoption of smart contracts

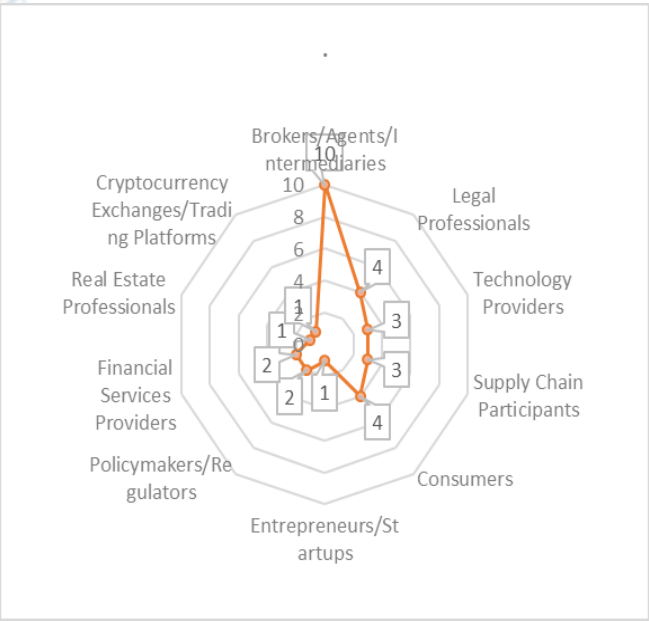

Figure 10 People who get impacted because of smart contracts Adoption.

- Brokers/Agents/Intermediaries,
- Legal Professionals
- Technology Providers,
- Supply Chain Participants
- Consumers
- Entrepreneurs/Startups
- Policymakers/Regulators,
- Financial Services Providers
- Real Estate Professionals
- Cryptocurrency Exchanges/Trading Platforms.

VI. CONCLUSION

The research findings suggest that traditional forms of contracts possess certain drawbacks. The survey reveals that adoption of smart contracts is likely to occur within the next five years. However, the integration process must overcome impediments such as upfront expenses and resistance to change for it to be effective. Adoption elements such as education, regulatory clarity, collaboration, and incentives are critical in addressing these impediments and may lead to improved contract management in the real estate sector.

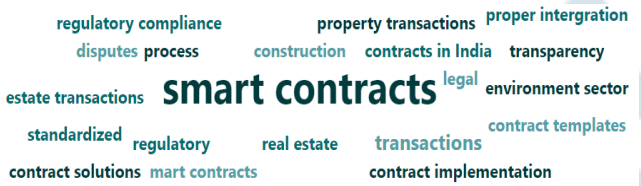

Figure 11 word cloud of respondents' perspective of smart contracts.

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