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User Adoption Barriers for Decentralized Business Applications

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ABSTRACT

Decentralized business applications (dApps) have emerged as transformative innovations within the digital economy, offering enhanced transparency, security, and autonomy compared to traditional centralized systems. However, despite their potential, the rate of user adoption remains limited due to multiple technological and behavioral barriers. This study aims to identify and analyze the key factors that hinder user adoption of decentralized business applications, focusing on technological complexity, lack of trust, usability issues, and regulatory uncertainty. The research employed a mixed-method approach that combined quantitative surveys of active blockchain users with qualitative interviews from industry experts to obtain comprehensive insights into user behavior and perception. The findings reveal that the main obstacles include insufficient user understanding of blockchain technology, concerns about data privacy, and the absence of standardized user experience designs, all of which contribute to low engagement and limited mainstream adoption. Furthermore, the study highlights that perceived risks and regulatory ambiguities significantly reduce users' willingness to transition from centralized to decentralized platforms. In conclusion, the research emphasizes the need for user-centered design, clearer legal frameworks, and targeted education initiatives to foster greater trust and accessibility in decentralized ecosystems. These results contribute to a deeper understanding of adoption dynamics and provide practical implications for developers, policymakers, and organizations aiming to promote sustainable adoption of decentralized business applications.

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1. INTRODUCTION

The emergence of blockchain technology has significantly reshaped the digital economy by introducing new paradigms of transparency, security, and decentralization. One of its most promising applications lies in decentralized business applications (dApps), which enable peer to peer transactions, eliminate intermediaries, and promote trustless systems where users have full control over their data and digital assets [1]. These applications have gained attention across various industries, including finance, supply chain, healthcare, and governance, as they offer potential solutions to inefficiencies in centralized systems. Despite these advan-

tages, the widespread adoption of decentralized business applications remains a complex challenge [2]. While blockchain offers technological benefits such as immutability, smart contracts, and distributed consensus, it also introduces new obstacles in terms of usability, scalability, and comprehension among non technical users. The global digital transformation has revealed that technology adoption is not merely a matter of innovation availability but also of user acceptance, trust, and accessibility [3]. Therefore, understanding the barriers that hinder user adoption of decentralized business applications is essential for developing strategies that facilitate smoother transitions from centralized to decentralized ecosystems [4]. The objective of this study is to explore and analyze the key factors that impede the adoption of decentralized business applications from the user's perspective. Previous research has primarily focused on technical aspects such as system performance, consensus mechanisms, and security protocols, while the human and behavioral dimensions of adoption remain underexplored [5]. Users often perceive decentralized platforms as complex and risky due to the lack of intuitive interfaces, uncertain regulatory environments, and the absence of clear accountability frameworks. Moreover, the novelty of blockchain based systems creates a knowledge gap between developers and end users, resulting in hesitancy to engage with technologies perceived as complicated or unreliable [6]. These challenges are exacerbated by the fact that traditional centralized applications such as those offered by major technology companies have set high standards for convenience and ease of use. In contrast, decentralized applications often require users to manage cryptographic keys, understand blockchain addresses, and navigate unfamiliar interfaces, all of which can discourage adoption [7]. Therefore, this research seeks to bridge the gap by investigating not only the technical but also the psychological and socio economic factors that influence user behavior and decision making in adopting decentralized applications.

To achieve this, the study employs a mixed method approach that combines quantitative surveys with qualitative interviews [8]. The quantitative component gathers data from users of various decentralized platforms to identify patterns in behavior, preferences, and adoption challenges. Meanwhile, qualitative interviews with blockchain developers, industry experts, and early adopters provide deeper insights into the contextual and experiential dimensions of adoption [9]. This comprehensive methodology allows for triangulation of data and ensures that both the measurable and interpretive aspects of user adoption are addressed. The significance of this study lies in its contribution to understanding how usability, trust, and regulatory factors shape user attitudes toward decentralized systems [10]. By identifying the main obstacles and the underlying reasons for user resistance, this research provides valuable implications for improving the design and communication strategies of decentralized applications. Developers and organizations can leverage these insights to create user centered solutions that reduce complexity, enhance trustworthiness, and align with user expectations. In conclusion, the study on user adoption barriers for decentralized business applications holds great importance for both academia and industry. As the global economy continues to evolve toward more autonomous and transparent systems, addressing user centric challenges becomes a crucial step in realizing the full potential of decentralized technologies. A thorough understanding of user adoption dynamics will not only aid developers and policymakers in designing better systems but will also foster greater trust, usability, and accessibility in the digital ecosystem. Ultimately, this research aims to contribute to the sustainable development of decentralized business applications by highlighting the necessity of integrating technological innovation with human centered design and governance frameworks. By overcoming existing adoption barriers, decentralized business applications can move from niche experimentation to mainstream implementation, transforming the way businesses and consumers interact in the digital era.

2. LITERATURE REVIEW

2.1. Technological and Architectural Barriers

In recent years, the literature increasingly highlights that technological and architectural issues form primary barriers to the adoption of decentralized applications (dApps) and blockchain-based business models. For example, A Statistical Examination of Utilization Trends in Decentralized Applications (Bärtl, 2023) examines usage trends and suggests that despite increasing interest, many dApps still suffer from poor user uptake due to frictions in the underlying architecture (e.g., complex wallet management, network congestion, transaction cost). Similarly, Items and Constructs of Blockchain Adoption in Software Development Industry: Experts Perspective (AL-Ashmori et al., 2022) investigates expert perspectives and identifies key constructs such as "technological readiness", "system complexity", and "integration with existing systems" as significant for blockchain adoption in software development contexts. These findings emphasize that beyond the promise

of decentralization, practical issues like interoperability, scalability, and usability must be addressed if dApps are to achieve broader adoption.

2.2. Behavioural, Organizational and Environmental Factors

Adoption of decentralized business applications is not solely a technology issue it involves human, organizational, and environmental dimensions. The review by A Critical Review of Blockchain Acceptance Models Blockchain Technology Adoption Frameworks and Applications (Taherdoost, 2022) synthesises adoption frameworks for blockchain and shows that constructs such as perceived usefulness, perceived ease of use, trust, organisational readiness, and external environmental pressures play key roles in acceptance and usage of blockchain technologies. Furthermore, as shown in Exploring Interoperability of Distributed Ledger and Decentralized Technology Adoption in Virtual Enterprises (Bokolo, 2022), organizational and environmental factors like interoperability among distributed ledger technologies (DLTs) and legacy systems also influence adoption decisions in virtual enterprise contexts. Thus, for users of decentralized business applications, issues of trust, awareness, training, organisational support, and the broader ecosystem context become critical when assessing adoption barriers.

2.3. User-centric Barriers: Usability, Trust and Knowledge

IFrom the user's perspective, adoption of decentralized business applications often faces steep hurdles in terms of usability, trust, and knowledge/awareness. For instance, the study on blockchain adoption in supply chains in India by Barriers to Blockchain Technology Adoption in Supply Chains: the Case of India (Khan et al., 2023) highlights that lack of adequate knowledge about blockchain, trust management issues, and absence of information sharing are among the foremost barriers for adoption. In another empirical context, the work The lure of decentralized social media: Extending the UTAUT model for understanding users' adoption of blockchain-based social media (Gruzd et al., 2024) explores how users' motivations for adopting blockchain-based social media are influenced by traditional technology acceptance factors (e.g., performance expectancy, effort expectancy) as well as new considerations like decentralization benefits and privacy concerns. These results suggest that for decentralized business applications, the user experience must be simplified and users must perceive tangible value and manageable risk before they commit.

2.4. Adoption and Diffusion Dynamics of Decentralized Business Applications

The diffusion of decentralized business applications (dApps) and blockchain-based business models remains limited despite their promise. For example, the literature review A Systematic Review on Blockchain Adoption reports that although blockchain technologies have been widely studied, many investigations stop at the adoption intention stage rather than actual usage or sustained adoption, indicating a gap between potential and realisation of use cases. Likewise, the taxonomy produced by A Taxonomy of Blockchain Technology Application and Adoption by Small and Medium-sized Enterprises (Kumar et al., 2024) shows that while SMEs express interest in blockchain adoption, structural constraints (resources, skills, business model readiness) limit their uptake. Together, these studies imply that decentralized business applications must not only address technological and social barriers but also align with business models, ecosystem readiness, and value propositions to achieve meaningful adoption.

2.5. Research Gaps and Implications for Decentralized Business Applications

From the reviewed literature it is evident that while substantial work has been done on blockchain adoption in general, and even on dApps usage trends, there remains a notable gap specifically in the context of decentralized business applications (as opposed to general blockchain or social media contexts). First, many studies focus primarily on organisational or industrial adoption (e.g., supply chains, SMEs) rather than end user adoption of business oriented dApps. Second, comparatively fewer studies explore sustained usage behaviour, trust evolution, and usability in real world business application settings. Third, the unique intersection of decentralization, business model transformation, and user behaviour in dApps requires integrated conceptual frameworks that combine technology acceptance, ecosystem readiness, and governance mechanisms. These gaps signal an opportunity for the present research to contribute by investigating user adoption barriers for decentralized business applications from a holistic vantage technological, behavioural, organisational and thereby provide actionable recommendations for designers, providers, and policymakers.

3. METHODOLOGY

3.1. Research Design

This study adopts a mixed methods research design, integrating both quantitative and qualitative approaches to provide a comprehensive understanding of the barriers affecting user adoption of decentralized business applications. The quantitative phase involves a structured survey distributed to active and potential users of decentralized platforms, while the qualitative phase includes semi structured interviews with blockchain developers, industry experts, and early adopters. This combination enables the triangulation of data and ensures both statistical reliability and contextual depth. The research design follows an exploratory descriptive orientation. The exploratory aspect aims to uncover emerging adoption barriers, whereas the descriptive element quantifies the frequency and intensity of these barriers across user groups. Figure 1 illustrates the overall research process.

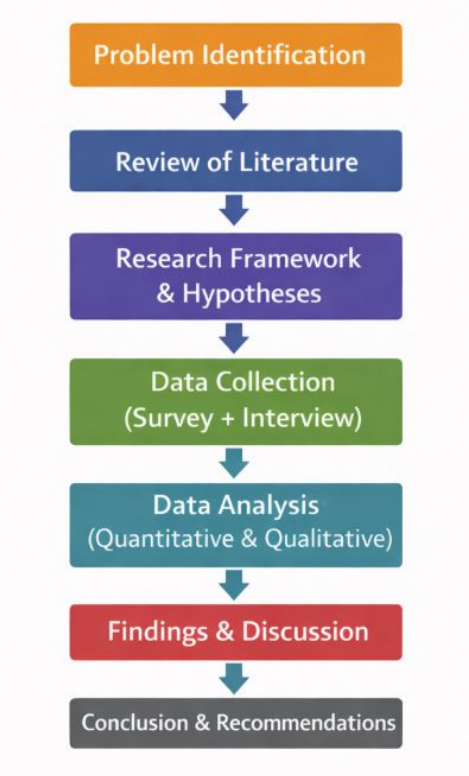

Figure 1. Research Process Flow

The Figure 1 illustrates a structured research process used in this study. It begins with problem identification, where the research gap is defined, followed by a review of literature to establish theoretical foundations and identify relevant prior studies. Next, the research framework and hypotheses are developed to guide the investigation. The process continues with data collection, combining surveys and interviews to gather both quantitative and qualitative data. This data is then examined through data analysis, allowing for comprehensive interpretation of findings. Finally, the process concludes with findings and discussion, which address the research objectives, and conclusion and recommendations, providing insights and practical implications for future research and implementation.

3.2. Population and Sampling

The population of this study consists of individuals who use or have experience with decentralized business applications (e.g., DeFi platforms, decentralized marketplaces, or blockchain-based productivity tools). The sample size for the survey was determined using Cochran's formula to ensure representativeness. A total of 250 respondents were targeted, selected through purposive sampling focusing on those with prior interaction with decentralized systems. For the qualitative phase, 15 key informants were interviewed using

snowball sampling, ensuring participants with relevant expertise in blockchain usability, regulation, and adoption strategies.

3.3. Data Collection Methods

Data were collected through two main instruments:

1. **Online Questionnaire:** Designed using Likert-scale questions (1 = Strongly Disagree to 5 = Strongly Agree) to measure user perceptions of technological, trust-related, and usability barriers.

2. **Semi-Structured Interviews:**Conducted with experts to gather in-depth insights about the organizational and regulatory dimensions of adoption.

All participants were informed about the confidentiality of their responses, and ethical approval was obtained prior to data collection.

3.4. Research Variables and Indicators

The research framework identifies three main variables: Technological Barriers, User Trust Barriers, and Regulatory Barriers, each operationalized through several measurable indicators as shown below.

Variable	Indicator	Measurement Type	Reference
Technological Barriers	System complexity, interoperability issues, transaction speed	Likert Scale (1–5)	Al-Ashmori et al. (2022); Bärtl (2023)
User Trust Barriers	Perceived security, data privacy concern, lack of transparency	Likert Scale (1–5)	Taherdoost (2022); Gruzd (2024)
Regulatory Barriers	Legal uncertainty, lack of governance standards	Likert Scale (1–5)	Bokolo (2022); Khan (2023)
Adoption Intention (Dependent Variable)	Willingness to use, perceived value, satisfaction	Likert Scale (1–5)	Kumar (2024)

3.5. Data Analysis Techniques

For the quantitative data, responses were analyzed using Statistical Package for the Social Sciences (SPSS) and SmartPLS 4.0. The following analyses were performed:

- **Descriptive statistics** to summarize demographic profiles and barrier perceptions.

- **Reliability and validity tests** (Cronbach's alpha ¿ 0.7, AVE ¿ 0.5).

- **Partial Least Squares Structural Equation Modeling (PLS-SEM)** to examine causal relationships among variables.

For the qualitative data, a thematic analysis approach was used. Interview transcripts were coded into emerging themes such as user distrust, technological frustration, and policy ambiguity. The qualitative findings were then compared and integrated with quantitative results for comprehensive interpretation.

3.6. Validity, Reliability, and Ethical Considerations

The validity of the research instruments was ensured through expert judgment and pilot testing with 20 respondents. Reliability was tested using Cronbach's alpha, ensuring consistency across variables. Ethical considerations included informed consent, anonymity, and voluntary participation. Data were securely stored and only used for academic purposes.

4. MANAGERIAL IMPLICATIONS

The findings of this study provide several important managerial implications for organizations, developers, and policymakers involved in the development and implementation of decentralized business applications (dApps). One of the key priorities for developers and technology companies is to emphasize user-centered design in the development of decentralized platforms. The results of this study indicate that technological complexity and usability challenges remain major barriers that discourage users from adopting blockchain-based applications. Therefore, simplifying system interfaces, improving onboarding processes, and designing intuitive and accessible user experiences are crucial strategies to enhance user engagement and adoption. In addition, organizations that aim to implement decentralized technologies should also invest in user education and awareness initiatives. Many potential users still have limited knowledge and understanding of blockchain technology and its practical benefits, which often leads to hesitation and uncertainty when interacting with decentralized systems. By providing educational resources such as training programs, tutorials, and easy-to-understand informational materials, organizations can help reduce the knowledge gap and increase users' confidence in utilizing decentralized applications.

Furthermore, the study highlights the importance of building trust and strengthening security assurance in order to promote wider adoption of decentralized technologies. Users frequently perceive blockchain-based systems as complex and risky, particularly due to concerns related to data privacy, financial security, and unfamiliar technological processes. As a result, managers and platform providers should prioritize transparent security mechanisms, clear privacy policies, and reliable technical support to foster greater trust among users. In addition, collaboration between businesses and regulatory authorities plays a critical role in addressing regulatory uncertainty surrounding blockchain and decentralized technologies. Policymakers are encouraged to establish clearer and more supportive legal frameworks that both protect users and encourage technological innovation. Such regulatory clarity can reduce uncertainty for both organizations and users, ultimately fostering greater participation within decentralized ecosystems. Overall, organizations that focus on improving usability, strengthening user education, enhancing trust, and aligning with regulatory developments are more likely to successfully accelerate the adoption of decentralized business applications.

5. CONCLUSION

This study aimed to analyze the key barriers affecting user adoption of decentralized business applications (dApps). The findings indicate that although blockchain technology offers significant potential to transform digital business ecosystems by enabling more transparent, secure, and decentralized transactions, several barriers continue to hinder its widespread adoption. The results demonstrate that technological complexity, limited user understanding, usability challenges, trust concerns, and regulatory uncertainty are among the most influential factors shaping users' reluctance to adopt decentralized platforms. Many potential users still perceive blockchain-based applications as complicated and risky, mainly due to insufficient knowledge about how the technology operates and the lack of clear and consistent regulatory frameworks. These issues create uncertainty and reduce users' confidence in utilizing decentralized applications, which ultimately slows the adoption process within the broader digital business environment. As a result, despite the rapid development of blockchain technologies, the transition toward decentralized digital systems remains gradual and requires further efforts to reduce these barriers.

Furthermore, the study emphasizes that improving user experience, enhancing technological literacy, and strengthening trust mechanisms are critical strategies to encourage broader adoption of decentralized business applications. Developers and organizations need to prioritize the simplification of system design, the improvement of interface usability, and the provision of clearer instructions that allow users to interact with decentralized platforms more easily and confidently. In addition, educational initiatives and awareness programs are essential to increase public understanding of blockchain technology and its practical benefits in business activities. When users possess sufficient knowledge and feel more comfortable with the technology, their perceived risks and uncertainties are likely to decrease, which may lead to higher levels of adoption. Therefore, organizations must not only focus on technological innovation but also ensure that their platforms are accessible, understandable, and user-friendly for individuals with varying levels of digital literacy.

At the same time, policymakers and regulatory authorities play a crucial role in shaping an environment that supports the responsible development and adoption of decentralized technologies. Establishing transparent, consistent, and supportive regulatory frameworks can reduce uncertainty and build stronger trust

among users, businesses, and other stakeholders within the digital ecosystem. Collaboration between developers, organizations, and regulatory bodies is therefore necessary to create a balanced ecosystem that encourages innovation while ensuring adequate user protection. By addressing usability challenges, improving public awareness, strengthening trust mechanisms, and developing clearer legal structures, decentralized business applications have the potential to achieve broader acceptance and contribute significantly to the future growth of the digital economy. Future research is also recommended to explore additional determinants of dApps adoption, such as cultural influences, economic incentives, and social factors, as well as to examine how user perceptions and adoption behaviors evolve over time as blockchain technologies continue to mature.

6. DECLARATIONS

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6.2. Author Contributions

Conceptualization: SW; Methodology: VR; Software: NL; Validation: MR and SW; Formal Analysis: NL and VR; Investigation: SW; Resources: NL; Data Curation: MR; Writing Original Draft Preparation: NL and VR; Writing Review and Editing: SW and MR; Visualization: VR; All authors, SW, NL, VR, and MR, have read and agreed to the published version of the manuscript.

6.3. Data Availability Statement

The data used and analyzed in this study can be obtained from the corresponding author upon reasonable request.

6.4. Funding

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6.5. Declaration of Conflicting Interest

The authors declare that they have no conflicts of interest, known competing financial interests, or personal relationships that could have influenced the work reported in this paper.

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