DOI 10.70286/ISU-01.04.2026.008

DECENTRALIZATION AND WEB 3.0 IN THE CONTEXT OF THE TRANSFORMATION OF THE DIGITAL ENVIRONMENT: TECHNOLOGICAL FOUNDATIONS, RISKS, AND SOCIAL PROSPECTS

Madelkhanov Serzhan Sunkarovich
Master of Natural Sciences, Mathematics Teacher
Starchenko Vadim Alexandrovich
Student
Magazow Farid Suleimanovich
Student
KAINAR School, Almaty, Kazakhstan

Abstract

This article examines decentralization and Web 3.0 as interconnected directions in the transformation of the modern digital environment. The aim of the study is to identify the essence of Web 3.0 as a new stage in the development of the Internet, to determine the role of blockchain, smart contracts, tokens, and decentralized applications, and to analyze the risks and social prospects of this model. The study employs comparative, structural-logical, and analytical methods. It has been established that Web 3.0 should be understood not only as a set of new technological solutions, but also as a transformation of the very logic of digital interaction, in which dependence on centralized intermediaries decreases, the role of the user increases, and the significance of digital ownership, digital identity, and verifiable data becomes stronger. The article demonstrates that blockchain serves as the technological foundation of Web 3.0, while smart contracts and dApps translate its principles into the applied sphere, and tokens and cryptocurrencies become part of the economic and infrastructural logic of the new digital environment. It is concluded that the future potential of Web 3.0 directly depends on digital security, legal certainty, the quality of technological development, and the level of users' digital literacy.

Keywords: decentralization, Web 3.0, blockchain, smart contracts, decentralized applications, tokens, cryptocurrencies, digital identity, digital security.

Introduction

In the 21st century, the Internet has become a fundamental infrastructure of modern society. Digital platforms are used for communication, education, financial transactions, data storage and transfer, as well as access to public and private services. However, the development of the digital environment has been accompanied not only by the expansion of opportunities, but also by increasing centralization. A significant share of online interaction has become concentrated within large platforms that control algorithms, user data, access conditions, and the architecture of digital behavior.

It is in this context that interest in decentralization is growing as an alternative model for organizing the digital environment. While a centralized system relies on a single center of control and data storage, decentralization involves the distribution of functions, responsibilities, and verification mechanisms among network participants. On this basis, the concept of Web 3.0 has emerged, which in its contemporary understanding includes blockchain, smart contracts, tokens, decentralized applications, digital identity, and new forms of ownership of data and assets.

This topic is particularly relevant because Web 3.0 increasingly affects not only the financial sphere, but also education, electronic documents, digital identity, trust mechanisms, and everyday digital practices. At the same time, in public perception, Web 3.0 is often mistakenly reduced exclusively to cryptocurrencies. Such an approach is insufficient, as it does not reflect its broader architectural, social, and institutional significance.

The purpose of this study is to identify the essence of decentralization and Web 3.0 as a new stage in the development of the digital environment and to determine their technological foundations, advantages, risks, and prospects for application.

Materials and Methods

The methodological basis of the article includes comparative analysis of centralized and decentralized systems, structural analysis of the evolution of the Internet, and the synthesis of specialized scientific-methodological and regulatory-oriented materials. The source base includes official publications by W3C, NIST, Internet Society, Ethereum.org, Bitcoin Developer, Cardano Docs, Polkadot Developer Docs, Chainlink Documentation, the Federal Trade Commission, and the European Commission.

The use of these materials made it possible to examine Web 3.0 not as an isolated technological innovation, but as a complex phenomenon located at the intersection of Internet architecture, the digital economy, security, data governance, and public institutions. This approach makes it possible to analyze decentralization not only as a technical principle, but also as a model for restructuring digital interaction.

Research Results and Discussion

1. Centralization as an Initial Limitation of the Modern Digital Environment. The analysis conducted shows that the modern digital environment remains largely centralized in nature. Most popular services provide users with convenience, high processing speed, and a unified interaction interface; however, at the same time, they create dependence on a single operator or a narrow circle of governing entities. This is reflected in the control over user data, the opacity of algorithms, the risks of access restriction, unilateral changes to rules without user participation, and the vulnerability of the system to single points of failure.

Therefore, decentralization emerges not as an abstract technological idea, but as a response to the real contradictions of the platform model. Its essence lies in the redistribution of control, functions, and trust among network participants. Such redistribution potentially makes the digital environment more resilient, open, and less dependent on intermediaries.

2. Web 3.0 as a New Stage in the Evolution of the Internet. A comparison of Web 1.0, Web 2.0, and Web 3.0 makes it possible to argue that the development of the Internet has followed a consistent and logical pattern. If the early Internet was primarily a space for reading and accessing information, and Web 2.0 became an environment of user-generated content and social platforms, then Web 3.0 represents the next stage—an Internet of participation, digital ownership, and distributed infrastructure.

The key distinction of Web 3.0 lies in the changing role of the user. The user ceases to be merely a consumer of services within a platform and gains the ability to act as a network participant, a holder of digital assets, a subject of data governance, and a user of services operating on the basis of open protocols. Thus, Web 3.0 is not merely a technological modernization, but a transformation in the logic of digital interaction itself.

3. Blockchain as the Technological Foundation of the New Digital Environment. Blockchain is the central element of Web 3.0. Its significance goes beyond ordinary data storage. Unlike a traditional centralized database, blockchain is a distributed ledger maintained by a network of participants according to common rules. It ensures the sequential recording of information, transparency of transaction history, cryptographic protection, and resistance to unnoticed alteration of records.

Consensus mechanisms are also of fundamental importance, as they allow network participants to agree on the overall state of the ledger without a single central authority. It is precisely for this reason that blockchain creates a new model of trust based not only on the authority of an organization, but also on the architecture of the system itself.

4. Smart Contracts and dApps as the Practical Implementation of Web 3.0. If blockchain creates the infrastructural framework of Web 3.0, then smart contracts and decentralized applications translate its principles into the applied sphere. A smart contract is a program that automatically executes predefined conditions within a blockchain network. In this way, part of the functions traditionally assigned to an intermediary is transferred into code and carried out according to uniform rules for all participants.

Decentralized applications, in turn, integrate blockchain, smart contracts, and the user interface into a single system. It is through dApps that the ideas of transparency, programmable interaction, and reduced dependence on centralized platforms receive practical expression. This is especially important for Web 3.0, as it demonstrates that the new digital environment is not limited to theory, but is already shaping applied forms of network interaction.

5. Tokens and Cryptocurrencies as an Element of Economic and Infrastructural Logic. One of the important findings of the study is the conclusion that tokens and cryptocurrencies should not be regarded solely as a means of payment. Within the Web 3.0 ecosystem, they perform a much broader range of functions: they are used to pay network fees, support security, incentivize participants, provide access to application functions, and may also be employed in governance mechanisms. For clarity, the main functional roles of the selected projects in the Web 3.0 ecosystem are presented in Table 1.

Table 1. Functional Roles of Selected Blockchain Projects in the Web 3.0 Ecosystem

Project	Type	Primary Function	Role in the Web 3.0 Ecosystem
Bitcoin (BTC)	Cryptocurrency / blockchain network	Transfer of value without a central intermediary	Historically the first practical model of decentralized digital money
Ethereum (ETH)	Blockchain platform / native asset	Support for smart contracts and dApps	Forms the foundation of the programmable Web 3.0 environment
Cardano (ADA)	Blockchain platform / native asset	Blockchain development based on a research-oriented approach	Represents a scientific approach to Web 3.0 infrastructure development
Polkadot (DOT)	Blockchain project / native token	Enabling interaction between blockchain networks	Highlights the importance of interoperability in Web 3.0
Chainlink (LINK)	Infrastructure blockchain project / token	Supplying external data to smart contracts	Connects blockchain systems with the external digital environment

As shown in Table 1, the selected projects reflect different technological and functional directions of Web 3.0 development.

An analysis of individual projects confirms this conclusion. Bitcoin historically demonstrated the possibility of transferring value without a central intermediary. Ethereum transformed blockchain into a programmable environment for smart contracts and tokens. Cardano illustrated a research-oriented approach to blockchain development. Polkadot highlighted the importance of interoperability between networks. Chainlink showed that smart contracts require reliable access to external data. Thus, digital assets in Web 3.0 are not an addition to infrastructure, but an organic part of it. A visual representation of the blockchain projects discussed in this study is provided in Figure 1.

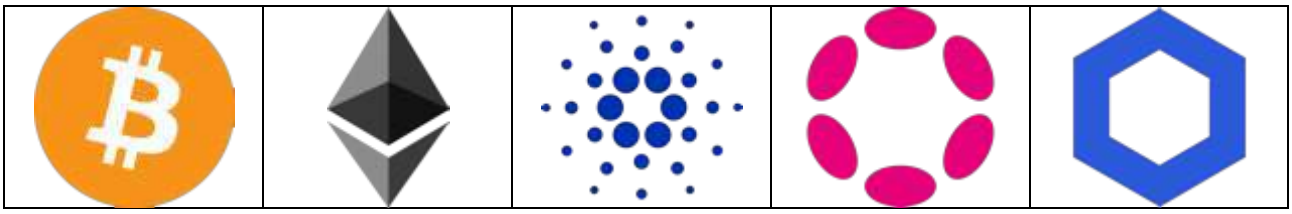

Figure 1. Logos of the Blockchain Projects Discussed in the Study: Bitcoin, Ethereum, Cardano, Polkadot, and Chainlink

6. Risks, Limitations, and Social Prospects of Web 3.0. Despite its considerable potential, Web 3.0 should not be assessed one-sidedly. Its development is accompanied by a number of serious risks. These include technological complexity, scalability problems, smart contract vulnerabilities, the volatility of digital assets, fraudulent schemes, and legal ambiguity across different jurisdictions. Therefore, decentralization itself does not eliminate risks, but rather changes their nature and redistributes responsibility.

Digital security occupies a special place in this context. In a decentralized environment, the user gains more autonomy, but at the same time assumes greater responsibility for safeguarding keys, seed phrases, wallets, and digital assets. This

makes digital literacy not an additional advantage, but a necessary condition for safe participation in the new digital environment.

At the same time, the prospects of Web 3.0 extend far beyond the boundaries of the crypto economy. The most significant areas include digital identity, verifiable credentials, electronic documents, digital wallets, and educational digital solutions. Approaches related to decentralized identifiers and verifiable digital credentials are already being developed today, creating the conditions for a more portable and user-controlled digital presence.

Thus, Web 3.0 should be regarded as a multi-level model of digital transformation that includes architectural, technological, economic, and social dimensions. Its future potential is determined not only by the novelty of the technologies themselves, but also by the quality of their implementation, the level of security, and the degree of their social adaptation.

Conclusion

The conducted research makes it possible to draw the following conclusions.

First, decentralization represents a natural response to the limitations of the centralized platform environment and reflects the aspiration for a more resilient, transparent, and user-oriented digital architecture.

Second, Web 3.0 is not a narrow technological niche, but a new stage in the development of the Internet, based on blockchain, smart contracts, tokens, dApps, digital ownership, and the enhanced role of the user.

Third, blockchain and smart contracts form the technological foundation of the new digital environment, while tokens and cryptocurrencies become an important part of its economic and infrastructural logic.

Fourth, the development of Web 3.0 is associated not only with opportunities, but also with significant risks. Therefore, its further expansion requires legal certainty, high-quality technological implementation, digital literacy among users, and a responsible approach on the part of developers and institutions.

Therefore, Web 3.0 should be regarded as a significant direction in the transformation of modern digital society, influencing data governance, digital identity, education, electronic documents, and the future of Internet interaction.

References

1. Berners-Lee T. Design Issues for the World Wide Web [Online]. – URL: https://www.w3.org/DesignIssues/
2. Internet Society. Market Concentration [Online]. – URL: https://pulse.internetsociety.org/en/concentration/
3. National Institute of Standards and Technology. A Security Perspective on the Web3 Paradigm [Online]. – NIST IR 8475. – 2025. – URL: https://csrc.nist.gov/pubs/ir/8475/final
4. Ethereum.org. Web2 vs Web3 [Online]. – URL: https://ethereum.org/developers/docs/web2-vs-web3/
5. Bitcoin Developer. Block Chain [Online]. – URL: https://developer.bitcoin.org/devguide/block_chain.html
6. Ethereum.org. What is Ethereum? (A Complete Guide) [Online]. – URL: https://ethereum.org/what-is-ethereum/

7. Cardano Docs. Introduction [Online]. – URL: https://docs.cardano.org/about-cardano/introduction
8. Polkadot Developer Docs. Overview of the Polkadot Relay Chain [Online]. – URL: https://docs.polkadot.com/reference/polkadot-hub/consensus-and-security/relay-chain/
9. Chainlink Documentation. LINK Token Contracts [Online]. – URL: https://docs.chain.link/resources/link-token-contracts
10. Ethereum.org. Ethereum security and scam prevention [Online]. – URL: https://ethereum.org/security/
11. Federal Trade Commission. What To Know About Cryptocurrency and Scams [Online]. – URL: https://consumer.ftc.gov/articles/what-know-about-cryptocurrency-scams
12. World Wide Web Consortium. Decentralized Identifiers (DIDs) v1.0 [Online]. – W3C Recommendation, 19 July 2022. – URL: https://www.w3.org/TR/did-core/
13. World Wide Web Consortium. Verifiable Credentials Data Model v2.0 [Online]. – W3C Recommendation, 15 May 2025. – URL: https://www.w3.org/TR/vc-data-model-2.0/
14. European Commission. European Digital Identity [Online]. – URL: https://commission.europa.eu/topics/digital-economy-and-society/european-digital-identity_en
15. European Commission. EU Digital Identity Wallet Home [Online]. – URL: https://ec.europa.eu/digital-building-blocks/sites/spaces/EUDIGITALIDENTITYWALLET/pages/694487738/EU%2BDigital%2BIdentity%2BWallet%2BHome
16. Madelkhanov S. S., Starchenko V. A., Magazow F. S. Decentralization and Web 3.0: Introduction to Blockchain, Tokens, and the Digital Future: educational and analytical edition. Almaty: KAINAR School, 2026. 58 p. ISBN 978-601-14-1006-9 [in Russian]**.**

COMPARATIVE ANALYSIS OF RECOMMENDER SYSTEM APPROACHES FOR IT CAREER GUIDANCE

Botsiura Iryna
Master's Student in Software Engineering
Kauk Viktor
Associate Professor of the Department of Software Engineering,
Candidate of Technical Sciences, Assistant professor
Department of Software Engineering
Kharkiv National University of Radio Electronics, Ukraine

Abstract. Career guidance for IT students is a complex multidimensional task that requires the ability to match an individual competency profile with the current demands of the IT labor market. This study presents the results of an experimental comparison of four recommender system approaches — Content-Based Filtering, ML Prediction