Blockchain Applications in Digital Marketing

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Abstract

The modern world is characterized by the intensification of the development of innovative technologies and their active introduction into various types of economic activity. Digitalization processes involve the use of a large number of specialized pieces of equipment that are connected to the Internet and implement specific functions. In a constructed system, server technologies, which allow to accumulation of large volumes of various information (structured, semi-structured, and unstructured) and process it owing to the powerful computing capabilities of Network-attached storage, acquire paramount importance. Powerful equipment for the implementation of complex mathematical models using large volumes of information contributed to the active development and use of various machine learning algorithms. Thanks to the application of various machine learning approaches, it is possible, based on the available information, to identify hidden relationships and develop effective management solutions that will allow optimizing existing processes at the micro, macro, and meso levels. The increase in the amount of information leads to the need to ensure the security of both individual users and large confidential databases. At the current stage of development, blockchain technology is actively used to ensure information security and prevent the falsification of information in databases. This technology is a modern data management system that allows you to place information in blocks in a specific way, control changes in transactions with a large number of independent electronic devices that coordinate any manipulations with existing data in the system. The effectiveness of using blockchain technology in the cryptocurrency market has led to the popularization of this approach in other types of economic activity. Since digital marketing, which generates large volumes of valuable information, is an integral part of the modern economic system, blockchain technology is used by companies to ensure a high level of reliability in the existing data protection system. The use of blockchain in the digital marketing system allows a company to increase the level of trust of the target audience and gain competitive advantages over other market participants.

Keywords

Blockchain, big data, communications, digital marketing, Internet, optimization, security.

1. Introduction

The active development of the cryptocurrency market is determined by the significant level of protection of highly liquid digital assets, which in its turn is explained by the use of blockchain technology. Due to the introduction of information into sequentially placed blocks, a network is created, which is characterized by the transparency of tracking transactions carried out in the created information system by all connected computing devices [1, 2].

Because of the presence of interconnection between all participants of the information system, the consistency of implemented transactions is ensured. In case of unauthorized data entry, it is not possible to affect all devices connected to the system. The massive

involvement of technical devices in the system and conducting a transaction through the system of agreements from each participant allows for ensuring a high level of reliability and protection of existing data due to the use of blockchain technology. The main element of the blockchain is sequentially placed blocks with relevant information about transactions. Blocks are placed in the order of completed transactions, and making changes to a specific chain involves informing each of the system participants and obtaining their consent to make changes. The efficiency of the system is achieved owing to the inclusion of a large number of decentralized participants in the system, which ensures multiple duplications of the existing chain with transactions and, with joint permission, makes it possible to make changes to the database. The placement of participants in various locations makes it impossible for fraudsters to simultaneously influence them and obtain illegal benefits. The reliability and transparency of blockchain have led to an increase in the use of technology in such areas as the energy sector, financial and banking spheres, the leisure industry, retail trade, etc. [3–5].

The processes of globalization and digitalization contribute to the strengthening of competition in various markets and lead to evolutionary transformations in the construction of company strategies. Qualitative transformations of companies are manifested in the creation of innovative models of interaction with users and the formation of demand for advanced products. The orientation of modern consumers to the Internet requires companies to intensify the use of modern digital marketing tools to obtain the maximum possible economic results. Thanks to the integration of relevant tools into the company's marketing strategy, it is possible to achieve optimal results in terms of building long-term relationships with the target audience based on the principles of loyalty and mutual trust. Today's users, especially representatives of Generation Z and Alpha, are focused on using advanced digital products, so they prefer companies with innovative solutions. The integration of blockchain technology into the company's digital marketing strategy allows for improving the competitive position on the market, increasing the popularity of products thanks to the integration of innovative solutions and a modern data security system, which contributes to the formation of the loyalty of the target audience in the long term. The combination of relevant digital marketing tools and blockchain technology allows the company to achieve the optimal level of conversion in specific space-time conditions. The increase in the number of companies that actively use blockchain in the formation of marketing strategies in the digital environment indicates qualitative transformations in the market and the intensification of the evolution of marketing approaches [6, 7].

2. Research Purpose

The complication of business processes in the digital environment and the intensification of the accumulation of large amounts of information require the use of innovative approaches to ensure effective processing and protection of information. Accordingly, blockchain technologies require further study to adapt to the needs of various fields, including digital marketing. The formation and implementation of effective marketing strategies involve attracting large amounts of monetary resources and focusing on the effective use of funds through relevant digital marketing channels. The process of monitoring the effectiveness of the use of funds to attract customers involves a comprehensive analysis of statistical information received from specialized companies for the distribution of advertising content. However, there are risks regarding the objectivity of the information provided about the actual impressions of advertising to the target audience. In today's Internet advertising market, fraud has become widespread, which causes significant losses to companies due to imitation of the behavior of real users when viewing advertising content. The use of fraud allows, thanks to the use of various fictitious actions, to achieve the set of KPI values regarding the effectiveness of the implementation of the advertising campaign, although the real indicators of the effectiveness of the advertising are much lower. Among the technologies for fraudulent acquisition of monetary resources within the limits of the advertising budget, attention should be paid to bots and click farms, which cause significant losses to companies. It should be noted that the described technologies are used not only by fraudsters but also by official participants of the advertising market on the Internet (marketing companies, advertising platforms, and aggregators) to fictitiously overestimate the effectiveness of the provided brand promotion services [8, 9].

The implementation of blockchain technology in the digital marketing system allows brands to avoid fraudulent actions by attackers and dishonest advertising companies thanks to the construction of a transparent transaction tracking system in the process of displaying informational messages to real consumers. Identification of real users and payment for the demonstration of advertising content to the target audience allows you to significantly increase the conversion rate and optimize the advertising budget [10, 11].

3. Models and Methods

Unlike the Internet architecture, which involves the existence of a large number of servers with centralized databases, the blockchain architecture is distributed, which allows each participant to personally approve and update new transactions entered into the system. Joint control of the data system due to the need to confirm a separate transaction by each participant allows to ensure the security of the available information. The effectiveness of blockchain technology is based on the principles of consensus, as a large number of independent participants in the network decide on the confirmation of each transaction.

Blockchain involves the creation of a list of blocks, each of which contains transactions arranged in chronological order. Existing lists are stored in the form of ordinary databases or flat files, which are supplemented by adding new records by the executed and agreed transactions.

The feature of blockchain operation involves the use of the following data structures:

1. Pointers are variables that contain comprehensive information about the location of another variable in the database being used.
2. Linked lists are a sequence of blocks that contain relationships between adjacent links in the form of a specialized pointer with specialized information.

The key element of the blockchain is cryptography, which involves the transformation of primary transaction data into encrypted objects. At the current stage of development, distribution has acquired two main approaches: algorithms with an asymmetric key and hash functions. Each of the approaches involves certain features regarding the transformation of primary data into encrypted elements [12].

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Asymmetric key cryptography involves the implementation of encryption by the use of encryption and decryption keys, which are generated automatically by the corresponding algorithm. In scientific literature and practice, cryptography with an asymmetric key is also called a public key. The process of interaction between communication partners in conditions of high scalability involves the use of a private key and a unique public key. During the interaction, keys are exchanged: the secret key generated by one party is encrypted using the recipient's public key. Thanks to its private key, the recipient can easily decrypt the encoded information. At the next stage, a full connection is made thanks to the secret encryption key.

A hash is a mathematical function that allows you to transform existing data of any length into data with a clearly defined number of characters. Accordingly, a file of a certain size at any iteration will receive a unique hash of the same size. The main property of hashes is the one-sidedness of the transformation, that is, the absence of the possibility of their transformation into primary data. To confirm the identity of the data, it is necessary to compare the existing hash with generated variants of hashes for a certain array of information. Hash technology allows you to ensure the security of the blockchain due to the inability to identify the input data contained in a specific hash. It should be noted that hashing differs from encryption, as it does not involve decrypting the received hash, which is an unreadable final element [13].

Thanks to the use of modern hashing algorithms, the blockchain manages to achieve the following advantages:

1. Avalanche effect. The use of specialized algorithms makes it possible to obtain a significantly transformed final result, provided there are minor changes in the primary data.
2. Uniqueness. A unique output is generated for each input.
3. Determinism. For a given input, using a hash function will always generate an unchanged output.
4. Speed. Thanks to the use of modern high-performance algorithms, it is possible to generate the final result very quickly.
5. Absence of reverse data transformation. The specificity of the implementation of the hashing algorithm does not allow the final result to be transformed into primary data.
6. "The effect of avalanche." Thanks to the specified hash function, binding occurs between consecutive blocks and ensures the integrity of information in the middle of each link. In case of unauthorized changes to the information in a certain block, a discrepancy will be identified and the blockchain will be broken, which will lead to the invalidity of the operation in the specified network.

An important element of each block is the Merkle root, which is a simple mathematical method of confirming each action that is performed within the Merkle tree. Thanks to the use of the Merkle root, the integrity and immutability of each of the blocks sent between participants in the peer-to-peer network are ensured [14].

The specificity of hashing involves the implementation of the process from the nodes of the lowest level, which are combined in the hash of higher levels. The construction of a certain number of levels using hashes leads to the creation of an interconnected system ending at the top, which is the root hash and is referred to in the literature as the Merkle root. The Merkle root includes complete information about each hash that describes a particular transaction in the block contained in the represented tree structure. Fig. 1 presents the features of Merkle root construction.
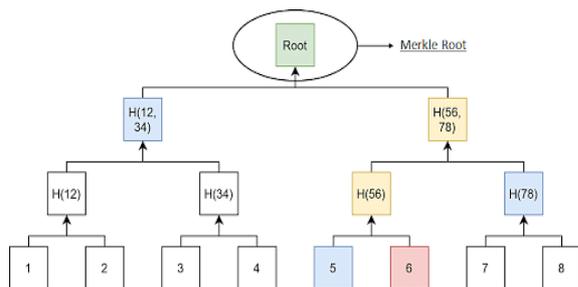
Figure 1: Merkle root [15]

In the next stage, we will consider the Merkle tree, which is a mathematical structure of data by the hashing of transactions available in a certain block. By the method of decentralization, the presented method allows you to quickly check the accuracy of the available data. The effectiveness of the Merkle tree implementation in the data encryption process led to the integration of the mentioned approach into the blockchain. In the process of building a Merkle tree, a hierarchical structure is used, which involves the step-by-step merging of hash pairs. Fig. 2 shows the Merkle tree structure.
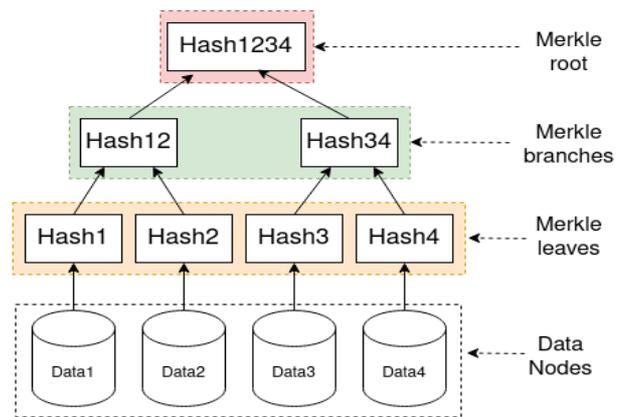
Figure 2: Merkle tree structure [16]

A Merkle tree consists of the following elements:
1. Data Nodes represent actual data.
2. Merkle leaves contain separate hashes, with relevant information in the middle [17].
3. The Merkle branch contains several Merkle leaves. A separate branch is represented in the form of a certain hash of a fixed size, which is generated based on the merging of Merkle leaves hashes.
4. The Merkle root is placed at the top of the structure and represents the final hash [18].

The Merkle tree functioning algorithm includes the following actions:
• Due to the use of the specified approach, the user gets the opportunity to identify the presence of a specific transaction in the block. In the process of checking the block for the presence of specific transactions, a digital imprint of operations is created.
• Merkle tree construction ends after creating a root hash, which includes a large number of hashed pairs of nodes.
• For each non-final hash, except for the first one, there must be a previous node, and the final node acts as a hash of transactional data.

- Due to the use of appropriate hashing algorithms, all transactions contained in a specific block are transformed into a hash.
- The implementation of hash functions leads to the creation of pre-hashed transactions in a hierarchical system. Merkle root is the final stage of the hashing process.

The use of the Merkle tree allows you to optimize the process of functioning of the blockchain and ensures the integrity of the completed transactions. The main advantages of using a Merkle tree in the blockchain are:

1. Due to the application of the specified approach, it is possible to check the accuracy of the existing database.
2. The specificity of building a tree-shaped data structure makes it possible to create small elements that can be divided into data bits during the network check process.
3. Thanks to the correct data format, the process of checking the accuracy of information is implemented within a short period of time [19].

Fig. 3 shows an example of a sequence of blocks in a blockchain, which represents a linked list of relevant records.
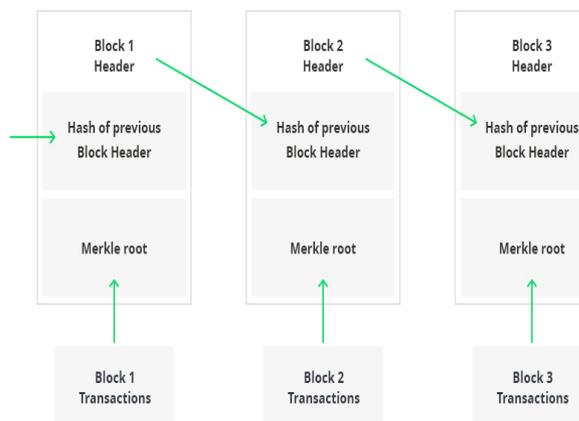
Figure 3: Scheme of the sequence of blocks in the blockchain [20]

In the process of researching the peculiarities of the functioning of the blockchain, it is advisable to consider the basic classification of the distribution of technology according to the principles of implementation. It is reasonable to divide the existing blockchain implementation algorithms into permissionless, permission, and a group with the characteristics of both approaches (Fig. 4). Permissionless blockchains enable all users to freely join the blockchain network as individual nodes based on the principle of pseudo-anonymity. Permissioned blockchains provide for the distribution of identification data of each user

among network participants and the availability of a system of access restrictions for certain nodes.
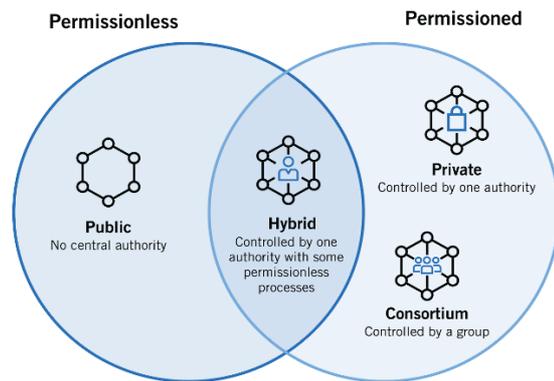
Figure 4: Types of blockchain [21]

All blockchain structures are divided into four categories:

1. Public blockchain architecture. The specified blockchain architecture provides the possibility of free access to the system for everyone who wants to join.
2. Private blockchain architecture. Only invited users who have received authorization according to a special invitation are allowed to participate.
3. Consortium blockchain architecture. This type of network is characterized by a higher level of security and scalability compared to public blockchain architecture.
4. Hybrid blockchain architecture. It is a combination of public blockchain architecture and private blockchain architecture, using the advantages of each approach.

4. Third Level Heading

In the context of the introduction of innovative technologies, digital marketing, as a high-tech type of economic activity, constantly attracts advanced approaches to provide individual companies with advantages in a highly competitive market. The competitive environment acts as a driver for the integration of innovative approaches into the marketing strategies of companies in the digital environment to establish effective communications with the target audience over a long-term period. Along with such technologies as virtual and augmented reality, machine learning, artificial intelligence, and the Internet of Things, blockchain also occupies a worthy place as a technology for the evolutionary development of digital marketing.

The implementation of blockchain technology in digital marketing is made in the following directions:

1. Stimulating the viewing of advertising messages. Modern users constantly view the digital environment to meet their personal needs (work, study, leisure, etc.). In the process of visiting various resources on the Internet and using specialized mobile applications, users are constantly in contact with advertising messages, which leads to the formation of a negative attitude towards advertising content. Tiredness from the oversaturation of advertising messages prompts users to take a set of measures to minimize the viewing of relevant informational content. As a countermeasure, companies implement more effective innovative approaches that are focused on promoting brands and their products in the digital environment. As part of the implementation of modern marketing strategies on the Internet, companies are beginning to actively use blockchain technology. Evidence of the effectiveness of the use of the mentioned technology in the process of implementing advertising campaigns is the increase in the number of views of advertising content and the level of conversion. The use of blockchain in advertising campaigns involves the construction of a system of incentives for users, which provides for the receipt of certain material and non-material benefits. The most common approach involves providing the user with a digital currency or token as a reward after viewing advertising content. The accumulation effect is used, which involves a small payment for viewing one advertising message, but familiarization with advertising content on an ongoing basis allows you to accumulate a significant amount of digital funds. Material stimulation in modern conditions acts as an effective tool for encouraging users to view the relevant thematic content of brands. Due to the prospect of receiving a material reward in exchange for a short period in the process of viewing advertisements, the level of coverage of potential users with advertising content increases. Constant viewing of advertising messages allows users to form a high level of loyalty to the company and its products and also encourages them to make relevant thematic purchases. Communications in the digital environment based on material incentives should be strengthened by the formation in users of a feeling of a personalized attitude of companies to each client [22].

2. Creation of a system with a high level of personal data protection. Blockchain technology provides for the implementation of highly effective principles for ensuring anonymity. Integration of the presented system into the company's marketing system makes it possible to ensure the protection of the personal data of consumers and prevent the theft of private information by third parties. Realizing that the company has a high-tech personal data protection system, customers are more likely to interact with the brand over a longer period. The formation of trusting relations between the company and the target audience contributes to the increase in the level of provision of relevant information by users in the process of making purchases. Modern companies during the formation of databases create a system of incentives to encourage users to provide personal data. Incentives are expressed in the form of cash payments, specialized bonus programs, discounts, and valuable content for users. Thanks to receiving relevant personal information from users, companies get the opportunity to create highly effective recommendation systems based on machine learning approaches, which allow them to identify new customers based on relevant metrics and offer relevant products and services. Along with this, the user gets an idea of a personalized approach from the respective company. Therefore, thanks to blockchain technology, companies increase the effectiveness of forming an offer of relevant products, and clients are aware of the high level of reliability of the preservation of provided personal data [23].

3. Building marketing campaigns according to the principles of transparency and reliability. In the conditions of globalization and the intensification of the introduction of digital technologies, there is a complication in the system of logistics chains and relationships between all participants in the market. The international division of labor and the creation of goods and services based on the principles of cooperation leads to the complication of identifying the actual origin of the country producing the products. For multinational corporations, globalization and the international division of labor do not cause difficulties, provided that components from different countries are accumulated for the production of the finished product. However, the existing system leads to large economic losses for legal producers due to the existence of a global market of counterfeit products that impersonate branded products but are characterized by a low

level of quality and danger to end consumers. Ordinary users face difficulties in identifying counterfeit products that are sold on the Internet by many trading companies. The integration of blockchain technology by companies allows consumers to easily track all stages of the creation of a specific product and its placement for sale in the appropriate place (a real retail establishment or a resource on the Internet). The use of blockchain technology in a brand's marketing campaign makes it possible to provide the target audience with reliable and comprehensive information about specific goods or services. Users with a higher level of probability will decide to purchase a specific product if they have objective information [24].

4. Cost optimization. In today's digital environment, there is a large number of companies with identical characteristics of goods and services, which requires the allocation of large financial resources to build effective marketing strategies. Improving marketing strategies based on blockchain technology by decentralization approaches allows the use of a smart contract system and minimizes advertising budgets. Technology makes it possible to get rid of advertising intermediaries thanks to the establishment of direct ties between companies and specialists in the production of advertising content and the implementation of effective information campaigns. In this context, intermediaries are seen as an inefficient link that leads to excessive use of monetary resources without the appropriate level of conversion growth in the digital environment. So, in the advertising market, blockchain acts as a technology for optimizing costs for the production and promotion of advertising content to the target audience. At the previous stages of the development of the global advertising market, there was a system of relationships between brands and publishers, specialized advertising companies, and freelancers with the mandatory participation of specialized intermediaries. However, the introduction of blockchain technology to the global advertising market led to a radical transformation of relationships [25, 26].

In the digital environment, influencers who communicate with the target audience by certain value orientations, generating relevant thematic content in specialized media, play a significant role. To increase the number of customers, companies actively involve thematic opinion leaders as part of their marketing strategies. Smart contracts implemented within the framework of blockchain technology enable companies to build more effective business relationships with opinion leaders who interact with a large number of potential customers. Blockchain technology makes it possible to identify fictitious accounts and cases of attracting non-existent subscribers. Thanks to an effective identification system, it is possible to evaluate the effectiveness of each influencer's work with real users in the relevant social media. Blockchain technology makes it possible to build an effective and fair system of remuneration for opinion leaders according to the objective involvement of customers and motivation to take targeted actions aimed at increasing the level of conversion in the digital environment. Continuously monitoring the influencer's performance with the target audience allows for the optimization of the advertising budget and helps to increase the level of user loyalty to the company and its products. Certain categories of opinion leaders use a significant number of fictitious followers to increase their value in the advertising market, which is reflected in the effectiveness of attracting a real target audience to advertised brands. Thanks to blockchain technology, it is possible to identify decent opinion leaders who are characterized by a high level of effectiveness of interaction with real consumers on the Internet.

5. Implementation of a flexible partner loyalty program. Awareness of the value of long-term relationships with customers prompts modern companies to introduce profile loyalty programs within the framework of sold goods and services, as well as taking into account the socio-economic, demographic, and psychological characteristics of consumers. Digitalization processes have led to the growth of specialized applications that are used by modern consumers on an ongoing basis. Based on the outlined trends, the company uses specialized applications in the framework of marketing campaigns that allow the implementation of flexible loyalty programs, focusing on the specifics of the behavior and values of different categories of consumers. According to their characteristics, the vast majority of modern users install several applications with interesting loyalty programs that meet their current needs. A negative phenomenon for brands is the availability and ease of installation of applications with loyalty programs, which leads to fictitious downloads of software solutions. For example, in the USA, according to profile studies, there are on average about 30 loyalty programs per household, but in fact, only

12 specialized applications are actively used. The availability of such services as the App Store and Google Play makes it possible to stimulate the target audience to install loyalty applications from relevant brands, but in many cases, there are difficulties in identifying the levers of encouragement to use these software products regularly [27].

Modern users have a positive attitude to effective points accrual systems within the framework of relevant loyalty programs, dynamic discount systems, and other material incentives are also in demand as a reward for a positive attitude towards the brand. However, the oversaturation of digital products and related information in the conditions of modern dynamic life leads to the loss of opportunities to use accumulated points, which is explained by the limited period of validity of bonuses within the limits of a specific bonus program. The rapid depreciation of earned bonuses negatively affects customer loyalty to the company associated with the respective bonus program. The inability to use earned bonuses promptly significantly reduces their value for consumers and leads to a decrease in the target audience's interest in the company's activities and its products. Accordingly, the image of the company on the market is gradually deteriorating.

Improvement of loyalty programs thanks to blockchain integration makes it possible to increase the level of user satisfaction with the company as a result of optimizing the functioning of the bonus program. Ensuring the transparency of the bonus accrual system based on the use of a decentralized blockchain approach helps to increase the loyalty of the target audience. The presented technology makes it possible to create complex systems of partnership relations between companies for offsetting bonuses accumulated by customers. The cooperation scheme incorporates the involvement of companies with complementary goods and services (for example washing machines, specialized means for washing clothes, accessories, etc.).

The combination of blockchain technology and specialized applications allows real-time tracking of points accrued by a specific brand and used by the specifics of the loyalty program. Information about new promotions is provided in the form of a notification signal to the client's smartphone, which contributes to ensuring the user's awareness of the appearance of useful offers from the brand. Recommendation algorithms integrated into applications offer optimal options for applying points based on the tastes of a particular user.

6. Improvement of social networks based on blockchain. For the vast majority of modern consumers, social networks act as the main channel of communication with other users on the Internet. The use of various social media allows us not only to enjoy communication and spend leisure time in a virtual environment but also to make purchases of necessary goods and services. It is also necessary to pay attention to the availability of specialized social networks that attract the target audience according to social, economic, demographic, psychological, and other features. The formation of specialized communities by a set of common features enables companies to quickly find the target audience and effectively interact with it [28]. Blockchain technology is also being used to optimize digital marketing strategies in social media. Modern users show an increased interest in decentralized social platforms based on blockchain, as the presented web resources are characterized by a higher level of implementation of innovative solutions. Realizing potential opportunities for interaction with the target audience, companies begin to actively develop their marketing strategies, accordingly adapting their presence in social media to their own capabilities and market needs.

Blockchain technology makes it possible to bring the level of protection of personal data and the reliability of payment systems in social media to a qualitatively new level of development. Thanks to the integration of crypto-currencies into social networks, the possibilities for paying for goods and services promoted by companies through the relevant profiles are significantly expanded. The new level of security of key processes leads to an increase in the popularity of blockchain in social networks among modern users, which opens new prospects for companies for an intensive level of development, an increase in the level of conversion, and the formation of a loyal relationship of users in the long-term perspective [29].

The conducted research testifies to the effectiveness and perspective of using blockchain technology to improve the marketing strategies of companies in the digital environment. The intensification of the development of innovations leads to the need to assess the directions of mutual combinations of various technologies to achieve a multiplicative effect. One of the directions of modern science, leading to the optimization of

processes for all types of economic activity, is the use of Data science approaches to process large data sets. Based on the outlined situation, it is advisable to focus further research on the study of the features of the aggregation of blockchain technology, machine learning, artificial intelligence, and other highly effective mathematical algorithms to optimize existing processes. Multidisciplinary solutions will lead to the appearance on the market of innovative digital marketing tools, which will be characterized by a higher level of personalized communications and the dynamic adaptation of recommendation systems to the needs of the consumer by changes in the influence of various factors.

5. Conclusions

Due to their effectiveness, blockchain technologies have become significant in many types of economic activity and continue to be actively implemented by companies to optimize key processes. The accumulation of large amounts of valuable information requires the use of effective database protection systems to prevent fraudulent actions by third parties. Thanks to the integration of blockchain technologies into digital marketing, it is possible to achieve a new level of company functioning and customer retention under the conditions of forming a high level of loyalty. On the one hand, companies get the opportunity to ensure transparency of key processes and interaction with the target audience as part of the implementation of appropriate marketing strategies in the digital environment. Along with this, it is possible to create an effective system of protection of users' data, which allows not only to attract new customers but also encourages users to provide relevant information in the process of interaction with a specific brand. Thanks to the use of blockchain, companies get the opportunity to bring the level of interaction with the target audience, especially representatives of generations Z and Alpha, to a qualitatively new level and ensure an economically justified level of conversion.

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