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Exploring the technology of Blockchain in Digital Advertising: Revolutionizing the conventional advertisement strategies

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Abstract

Digital advertising is a highly credible form of advertising which targets the audience selectively, however, a large number of intermediaries are involved in the digital advertising ecosystem which ads cost and fraudulent activities in the whole process. Blockchain is seen as the possible solution for all these issues in digital advertising and the present study has investigated the revolutionary capabilities of blockchain in the field of digital advertising. The study has reviewed the current progress blockchain technology has made and the solution it extends. The results projected that blockchain technology has left a positive impact on digital advertising by reducing costs, increasing transparency, reduction in frauds, and increasing value of the stakeholders. However, more studies are required to gain in-depth knowledge, whether blockchain is ready to be implemented or not in the field pertaining to digital advertisement.

Keywords: *Blockchain Technology, Digital Advertising and Conventional Advertisement Strategies*

1. Introduction

The 21st century has been the era of digitization where digital platforms pose at the forefront for multiple sectors such as marketing, sales, education, and healthcare. Owing to its increased ease of establishing communication, digital platforms serve as the most highly preferred medium for advertisements. With the exponential growth rates of digital platforms in no time, it has undoubtedly managed to grab most of the customers' valued attention. Increased customer attention not only promotes the product's popularity but also has a significant impact on product sales. A digital platform-based advertising greatly varies from the conventional advertising in that the former provides the customers with the provision of direct information exchange and placing of the order. The selective targeting of the audience in digital advertising further adds to its credibility. The different forms of online advertising may include contextual ads, banner ads, blogs, social network advertising, interstitial ads, online classified advertising, and many more. The current study attempts to explore the implications of blockchain in the digital advertising sector.

Blockchain can be referred to as a distributed database solution that serves the two principal parties involved in any transaction by maintaining their continuously growing list of data records. Blockchain technology thus allows alleviating interruption from any third party thus facilitating the creation of a decentralized environment where the participating nodes are only entitled to the rights of conducting any transactions. Such a decentralized nature of the blockchain system not only makes it transparent but also highly reliable when compared to conventional centralized transactions based on a third-party involvement.The realization of the blockchain technology in actual terms was made through the introduction of the Bitcoins (Yli-Huumo, 2016).

The concept of blockchain is not just limited to Bitcoins. People with time have realized its potential implications in the advertising or digital sector. It is presumed that the market for global blockchain technology would reach a peak of $23.3 billion by 2023. However, such exponential growth is not just based on its application as Bitcoins but also on various other sectors such as advertising, marketing, management, accounting, and communications. The narrow spectrum of application has now been broadened when blockchain as a technology is considered for solution. Standing in2020, people not just link to Bitcoins but also look upon it as a potential instrument that could bring about a revolution in the advertising sector. Digital is the call of the hour and it is expected that digital business all around the globe will account for a business of $427.26 billion by 2022. Despite being a significant emerging area, the sector has been dominated by frequent reports of fraud events owing to the limited transparency. Reports have revealed a loss of about $6.5 billion in the year 2017 due to fraud in the

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advertising sector. Realizing the severe toll fraud can have on the advertising income people diverted their focus towards blockchain and its potential application in this sector for a resolution. The initiation began in 2017 when some of the first blockchain-based advertising projects turned up to address the issues of fraud. Such attempts depicted significant promise for the future leading to its further development. The following year, i.e. 2018 posed as the golden period for the majority of the companies to invest in blockchain projects. The great potential and willingness of companies to invest more money also turned out to be fruitful which has been evident from the 21% rise in the site visits for Toyota when blockchain analytics was implemented by the company (Guzenko, 2019).

Several challenges are associated with the blockchain technology in advertising fields such as energy consumption and carbon footprints of the internet (Parssinen et al., 2018). Limited studies have investigated blockchain technology, the need for the same in the advertising field and benefits it brings to a company. Therefore, current study aims to further explore the field and revolution which can be brought in through blockchain technology.

2. Research Objectives

The study aims to fulfill the following objectives:

- To review blockchain technology in digital advertising.
- To assess the revolutionary capabilities of blockchain technology in digital advertising.
- To examine the current progress of blockchain technology in digital advertising.
- To analyze blockchain platforms and solutions in the field of digital advertising.

3. System Implementation

Analysis: The section will be a representation of the various concepts related to the application of blockchain technology in digital advertising will be discussed. It will include a brief description of the topic in the form of an overview. Further, it will include the Blockchain background of what, why and how it is used and implemented. Lastly, it will include the implementation of Blockchain in Digital Advertising Framework.

3.1 Overview

Blockchain technology has gained immense popularity in recent times owing to its ability to solve issues related to networking such as verified exchange over a computer network without involving any centralized governance institution. In this regard, blockchain aids by creating a distributed ledger of transactions that can be duplicated across many computers. Transaction visibility is enhanced by the provision of being read and verified by any participating individual (McConaghy et al., 2017). The Blockchain technology has been explored by several companies, some of them being discussed as case studies in the following paragraphs.

Mattila et al. (2016) in their "case study of a shared platform with blockchain technology" attempted to ascertain the potential of blockchain technology being used as the architectural basis for sharing and efficient management of product-centric information. The author believed product-centric information management to be the key concept in "understanding the interoperability between increasingly intelligent and autonomous goods in distributed computing architectures". Blockchain technology has been exploited in the current scenario to fathom the possible development trajectories for multi-sided platforms, across multiple industry sectors. The results of the study revealed blockchain to satisfy most of the industry requirements that have been outlined while conducting discussions with the blockchain technology developers. Regarding interacting modifications and its necessity in product-centric data management has been debated and thus calls for additional research to provide further clarification. The application of blockchain in sharing of product-centric information has been immense and promising. Reviewing the existing development trajectories of blockchain technology it can be said that to attain higher network effects it is essential to establish the interdependencies between the product data of individual product items.

The following case study focuses on the Ascribe service sector. The Ascribe service has been attending to the public needs from April 2014. Since its inception, the service has been associated with more than 4500 users who contributed with 38,000 editions of digital property in different media forms which included images, videos, 3D designs, screensavers and software, and other media.The main purpose of Ascribe has been to address the marketing challenges associated with digital art. In

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doing so they presented the phrase "Where's my stuff?" that conceptualized a two-factor problem, the first one being the issue of "my stuff" and the second one deals with visibility. "My stuff" deals with claims pertaining to ownership that may include claims for ownership transfer and granting permission to the usage rights. Visibility, on the other hand, deals with the usage of the artists work over the digital platforms. It mails encompasses three questions- where, how and by whom the artist's work is being used. While addressing the two-factor problem, bitcoin blockchain made its appearance. Implementing the blockchain technology, Ascribe paved the way for the users to record claims about their rights to a work (Nakamoto, 2008). The Bitcoin blockchain serves as a reservoir of data wherein data can be added when any transaction is being performed but there remains no provision for withdrawal of the data, once it has been added. The participating nodes, however, remain unaware of the protocol on which the bitcoin program runs and the information it carries. The primary application of bitcoin protocol design has been to ease out the transaction process. The same is attained by providing an easy means of value transfer and making of the payment. However, in the context of ascribing the application of bitcoin in payment transactions does not hold any significant importance. Instead, Bitcoin blockchain has been explored by Ascribe for the purpose of information storage. It stores information related to the artwork and the changes in the ownership of the artwork. There exists multiple other protocols such as OpenAssets (Theron, 2013) and Counterparty (www.counterparty.io) that could aid in the process of transfer of non-financial assets in the form of "tokens" on a blockchain platform. However, such technologies fail to satisfy the Ascribe's need for ownership processing in two key areas, namely, feature set and the legal requirements. Since there are many of the existing blockchain protocols that were not useful when the specific needs of the Ascribe terms of service (ToS) were considered, so, they instead preferred to develop a new one termed as Secure Public Online Ownership Ledger (SPOOL). SPOOL was made available to the public using a Creative Commons license (https://github.com/Ascribe/spool) platform. The primary basis of SPOOL has been set up keeping in mind the framework for Bitcoin blockchain, however, the additional modifications make it compatible and suitable as per the needs of ascribing such as secured registration by using a timestamp. SPOOL thus often has been termed as a modern version of the "poor man's copyright" (McConaghy et al., 2017).

BitClave is another example who implemented blockchain technology in the marketing sector. BitClave is a marketing technology-based company who utilized blockchain to avert the conventional scheme in the marketing sector wherein advertising is always through the involvement of an intermediary. For example, famous social platforms on the digital space such as Google, YouTube, and Facebook are paid money by respective companies to display their ads in their network outside of their owned inventory, which otherwise is also called operated inventory. However, blockchain technology allows to bypass such involvement of mediators by directly connecting the two primary parties.Blockchain, thus establishes a direct contact between the website owners and advertisers owing to the provision for automatic validation. Elimination of the middlemen makes the process less complex and more transparent between the users. A significant positive impact upon the cost of the advertisements at digital platforms is also noted when no middlemen are involved. Implementing a smart contract based on a program that facilitates automatic currency transfer between the participating nodes or parties, BitClave overcame the need to pay a hefty amount of money to the middlemen like Google and Facebook (Single Grain, 2020).

Another implementation of blockchain in the advertising sector has been by XCHNG™. The primary motive herein also has been the same, that is to limit the expenses related to the involvement of middlemen in the current digital advertising sector. Not only do traditional advertising policies call for increased expenditure on middleware and mediation, but it also enhances the risk of fraudulent activities. XCHNG™ attempted to target such an unsecured and non-standardized advertising sector by establishing an open and unified blockchain solution. It is believed that blockchain technology would make way for the much-required revolution that transforms the digital advertising industry into a stable, secure, efficient, and transparent one. The decentralized advertising model proposed and implemented by XCHNG™ thus makes both advertising and marketing much easier by peer-to-peer buying and selling (XCHNG, 2020).

3.2 Blockchain Background

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Blockchain technology is a combination of cryptographic technology and peer-to-peer computing that ensures the establishment of secure and direct transactions between the participating nodes without the involvement of any intermediary or third party. Blockchain has been defined by Seebacher et al. (2017) as a distributed database that can be accessed by the members of the peer-to-peer network. The primary basis for blockchain technology is a distributed ledger that comprises a sequence of blocks, which serves as a record for the complete list of transactions that takes place. A typical block of a blockchain comprises a block header and the block body. The block header further is made up of the following components- 'Block version', 'Merkle tree root hash', 'Timestamp', 'nBits', 'Nonce', and the 'Parent block hash'. The block body, on the other hand, consists of the transaction counter and transactions. The size of the block and that of each transaction determines the maximum number of transactions that a block can accommodate. In blockchain technology validation of any transaction is made by the asymmetric cryptography mechanism. However, for a non-secure environment digital signature based asymmetric cryptography is utilized (Zheng et al., 2017).

A block in a blockchain is formed from the grouping of the nodes that executes and records the transactions. The addition of block is limited to one at a time and each block follows a sequence that connects it mathematically to its preceding block. During the entry of the data in a blockchain, the same are time-stamped and are shielded from any kind of tampering in the future making it secure with the addition of more data in the future. In this regard Zhu et. al (2016), referred to blockchain as distributed ledgers that offer "data security, transparency and integrity, anti-tampering and anti-forgery, high efficiency, low cost". Undoubtedly, blockchain has been a revolution with its own pros and cons that possesses the immense potential of being used in a myriad of business activities. However, much of its application in the initial phase has been limited to the financial sector. This could be justified by the successful application of the blockchain technology in the form of crypto-currency Bitcoin. Despite its high popularity in the financial industry, blockchain technology and distributed ledgers also have been instrumental in attracting the attention of the researchers to explore its potential in different industries (Nofer et al., 2017).

The history of development of blockchain dates back to 1998 when computer scientist Nick Szabo, first put forward his work on 'bit gold', a decentralized digital currency. Two-year post to this, i.e, in 2000, Stefan Konst published both his theory of cryptographically secured chains and the ways in whichthis theory can be realized in actual terms.In 2008 and 2009 the model for blockchain was presented and implemented respectively. First implementation of blockchain was in the form of public ledger that aided transactions with the use of bitcoin. Bitcoin blockchain technology marked the beginning of the era of blockchain grabbing the eyeball of researchers all around the globe. Attempts were made to explore the potentiality of the technology in other sectors of the society such as healthcare, advertising and many more. In 2014, Blockchain was separated from the currency. Instead, its scope in facilitating inter-organizational transactions was explored. This change ushered in a second phase in the blockchain technology often termed as Blockchain 2.0. The primary focus of Blockchain 2.0 has been beyond currency and to quest for the application field wherein blockchain can be implemented to its full potential. Blockchain 2.0 is further succeeded by Blockchain 3.0 that is the digital era of blockchain. Blockchain 3.0 deals with the implementation of blockchain in the digital sector, beyond finance and markets. The different focus areas of Blockchain 3.0 have been government, smart cities, health records, education, and science (Nakamoto, 2008; Sun et al., 2016; Swan, 2015; Ertemel., 2018).

Zheng et al., (2017) in their study identified the four key characteristics of blockchain. They are as follows-

➢ Decentralization- This the first and foremost of all since the primary basis of blockchain has been to limit the intervention from and middlemen or mediators. Blockchain based transaction systems differ from the conventional transaction systems in a way that the former needs no validation from any centrally trusted agency such as a central bank. No involvement of such centrally governed organizations makes blockchain more cost effective and also helps to overcome the performance bottle-necks if any that may arise due to the central servers. Instead of involving third parties

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blockchains are based upon consensus algorithms that facilitate maintenance of data consistency within distributed networks.

➢ Persistency- Since blockchain establishes direct contact between the participating nodes, the system remains highly transparent and persistent. In Blockchain once a data related to a transaction is entered it remains there forever and can be accessed in the future as and whenrequired. The validation of the transactions can be done in no time and honest miners ensure that there is no allowance for invalid transactions.

➢ Anonymity- In the blockchain, the identity of the user remains undisclosed. Users are provided with a unique address that allows them to interact with the blockchain but provides no information regarding the actual identity of the user. In this regard, it can be said that blockchain owing to its own intrinsic constraints fails to guarantee what is referred to as ideal privacy preservation.

➢ Auditability- Another pertinent feature of blockchain is the ease of auditing. Bitcoin blockchain explores the Unspent Transaction Output (UTX-O) model to store data related to user balances. Thus, any transaction is required to refer to previous unspent transactions and once the transaction is complete the status in blockchain switches from unspent to spent transactions. This makes transactions easy to be verified and tracked.

Despite the immense promise that blockchain holds for the future it does suffer from some challenges as well. Most of the challenges are technical, the first one being the issue of scalability. With a size limited to 1 MB, the bitcoin network could accommodate transactions at a rate of 7 per second. Such bitcoin networks cannot support high-frequency trading and thus calls for larger size blocks. However, again introducing larger blocks would compromise in the storage capacity and network propagation rates, thus making way for centralization in blockchain. Establishing a balance between block size and security thus poses to be a tough challenge that is yet to be attained. Another challenge has been the discrepancy in the share for revenue. Some miners intentionally hide their mined blocks to earn greater revenues that induce branching in the blockchain which in turn hinders its development (Biryukov et al., 2014; Eyal&Sirer, 2014). Another potent challenge for blockchain has been the privacy concern. One of the key characteristics of blockchain that restricts the retrieval of any data that has been inserted once directly impacts on the data privacy standards. This holds significant importance when the said data is personal data or metadata that could easily reveal an individual's identity. The unique transparency policy of transactions followed by blockchain poses to be less suitable for the banking sector as it fails to comply with the needs of the same. This is mainly because of the fact that banks do not prefer to share their precise information related to the transactions with their competitors. Moreover, they are also bound by the law that forces them to maintain their privacy. However, to ensure that such privacy boundations do not restrict the scope for blockchain technology application can be attained by designing appropriate technology-based solutions that take into consideration the privacy-protecting blockchains. Such attempts may include limiting the access to the blockchain network only for the "trusted" nodes and incorporating an encryption program that transforms the data on blockchain into an encrypted one (McKinlay et al., 2018; Herrera-Joancomartí& Pérez-Solà, 2016).

3.3 Implementation of Blockchain in Digital Advertising

Online based editorial content and advertising accounts for 75% of the total revenue and thus holds a significant position in the Internet's economy. The reports have revealed online advertising revenue to strike a double-digit growth with the US alone generating $72.5 billion revenue in the year 2016 (IAB, 2017). Realizing the scope for online advertising, a shift towards programmatic media trading has been noted in this sector. Programmatic advertising intends to make the online advertising market easily accessible for the small and medium scale advertisers and publishers. Despite its attempt to make digital advertising more popular, programmatic advertising does suffer from some disadvantages such as increased risk of fraudulent activity. Challenges are further enhanced as large volumes of transactions limit the detection of fraudulent activities (Pastor, 2016). This initiated the search for technologies that could ease out the digital advertising sector. In this regard, Blockchain has been a new entrant and already has managed to grab the eyeballs of the stakeholders owing to its ability to address the burdening issues of online advertising.

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The study titled- "Is Blockchain Ready to Revolutionize Online Advertising?" by Parssinen et al., (2018) has been a significant one. The online advertising sector has been a promising one with an annual turnover of around 200-billion-dollar. However, increased opening for involvement of the middlemen have made the advertising ecosystem to become infested with fraud individuals who exploited the platform for individual benefit thus impacting the overall efficiency and popularity of the sector, user data and advertising budgets. Blockchain poses to be a promising solution that could address the critical issues of the online advertising supply chain. In this regard, the current study attempted to review the progress status when blockchain is considered in the digital advertising sector. Assessing the status the study also presented the new requirements for blockchain-based online advertising solutions. Results of the study indeed identified blockchain to have a significant impact upon the digital advertising sector, but the author also made it a point to indicate that the work in this regard has been very limited. Despite realizing the potential of blockchain in the digital advertising sector there have been very few evidences that portray the large-scale implementation of the technology. Thus, additional research is imperative to explore blockchain technology and its potentiality in the digital advertising sector before being considered as a trusted alternative for the current online advertising marketplace based on Open Real-Time Bidding (Open RTB).

4. Development of Smart Contracts framework for Digital Advertisers

The concept of blockchain was first introduced in 2008. Initially blockchain was limited to financial transactions owing to its emergence in the format of cryptocurrency Bitcoin that gained immense popularity in no time. However, with continuous progress in the field of blockchain it has witnessed subsequent development that led to the era of Blockchain 2.0. It is Blockchain 2.0 that first implemented the concept of 'Smart Contracts'. The introduction of the term 'Smart Contracts' dates back to 1997 when it was first introduced by Szabo (1997). 'SmartContracts' were referred to as a combination of computer protocols and user interfaces that facilitated execution of the contractual terms. However, realization of the concept of Smart Contract in actual terms only happened with the introduction of blockchain technology. Blockchain undoubtedly has been the major driving force that popularized the concept of 'Smart Contracts'. This primarily stems from the fact that blockchains compared to other available technologies that were present at the time of introduction of the 'Smart Contracts' facilitated its easy implementation. It was believed that 'Smart Contracts' would help revolutionize conventional business contracts by replacing the need for lawyers and banks to validate the contract based on the predefined aspects (Fairfield2014).

In Blockchain 2.0 'Smart Contracts' or programming logic are inserted directly into the blocks of the blockchain in a cryptographic manner. The Smart contracts can be programmed directly and their execution in the blockchain remains automatic with completion of each term. Thus smart contracts have been effective in inducing a trust factor when business transactions at digital platforms are taken into consideration. Such contracts also limit the need for any intermediary parties to ease out complex multi-party transactions. Some of the promising arenas where the application of smart contracts holds promise are supply chain integration, smart properties, mortgages, titles, and many more which have the provision embedding business logic (Ertemel., 2018).

Ethereum serves as a significant example of smart contract implementation using blockchain technology. Ethereum first proposed by Buterin(2014) poses a decentralized system that treats smart contracts as first-class citizens. Ethereum has been an extension of the Bitcoin blockchain that was introduced with the intent to expand the scope of application of blockchain (Nofer, 2017).

5. Impact of Blockchain in Digital Advertising

Blockchain has been a new concept that gained immense popularity when first implemented in the form of Bitcoin. Since then much of the focus of blockchain technology has been in the finance sector. However, in recent times research has indeed revealed a significant potential of blockchain in several other fields of which digital advertising has been a prominent one. The popularity of blockchain has been significant owing to its successful implementation in the digital advertising industry. The following sections would elaborate on the positive impact of incorporating blockchain technology in the digital advertising sector.

5.1 Eliminating Fraud

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Increased chances of fraud activities in the digital space indeed poses as a major roadblock towards utilization of digital technologies to its full potential. Several instances have revealed the significant impact of fraudulent activities on the overall business of digital advertising thus creating trust issues among the general population. Reports have revealed marketers to bear a hefty loss of $7.2 billion in the year 2016 owing to fraud in the digital advertising sector (Slefo, 2016). In recent times detecting the frauds have become immensely difficult owing to their ability to strategically camouflage themselves. However, in this regard blockchain technology has been promising to limit such fraud activities. It provides opportunities for redesigning of the system that could restrain occuring of any fraud activities (Cai & Zhu, 2016). Sarda et al., (2018) in their study contemplated the effectiveness of blockchain technology in eliminating work history related fraud. Under several instances verification of the data by third parties who are relied upon for the purpose is not only time consuming but also creates loopholes for fraud activities to occur. Similar concept also holds true in the digital advertising sector. Removal of middlemen makes the system more transparent and trustworthy. Further, by providing provision for tracing down the advertising dollars to their ultimate endpoint, also makes blockchain highly effective in reducing fraud activities (Mire, 2018).

5.2 Reduction in Costs

The positive impacts of blockchain remains to be interconnected. Since blockchain has been instrumental in limiting the involvement of middlemen thus making the system more transparent and reducing the chances of fraud activities, a considerate impact as a result is also realized on the financial aspect. Blockchain holds significant promise in achieving a substantial cost saving in sectors where blockchain technology has been utilized. This is mainly achieved through the cost-cutting on the manual activities such as aggregating, amending and sharing data, and manual reporting and auditing of documents routinely. Herein, blockchain comes to the rescue by limiting the need for such manual activities thus creating provision for extra time to focus on the value-added activities. Cost saving using blockchain technology is also realized from the replacement post-trade reconciliation and settlement that are not only time-consuming but also highly expensive (Gregorio, 2017). Cocco et al., (2017), also identified blockchain technology as the most suitable candidate that could optimize the global financial infrastructure thus facilitating attainment of sustainable development. In the digital advertising sector blockchain technology is believed to induce cost savings by bringing the advertisers and publishers in direct contact without involving the middlemen who peddle ad space to earn profit thus adding on to the overall expenditure of digital advertisements (Mire, 2018).

5.3 Increases in Transparency

The digital advertising industry has a trust problem. A report published on The Economist revealed agencies in the United States to remain associated with routine reselling of ad space to the clients at markups as high as 90% (The Economist, 2016). Another report by Varnica& Marshall, (2016) stated that Facebook's video ad viewing metric only considered videos that were viewed over three seconds resulting in the 60–80% overestimation of the efficiency of video ads on the platform. Blockchain has been believed to address such trust issues by establishing direct contact between the participating members without involvement of any middlemen and ensuring time stamps on the duration of a video ad as an example thus by clearly helping brands to know how many seconds a consumer to whom it was directed at actually watched the video. The changes of mistrust and fraud activities increase when middle parties are involved, and the primary parties are made to interact with each other via the intermediary. However, in blockchain, the provision for easy data collection and data sharing enhanced its transparency thus eliminating the multiple pain points prevailing in the advertisement sector such as posting of ads on fake sites, hyperinflation and fraudulent metrics (Mire, 2018).

6. Conclusion

The current study has been an overview of blockchain technology and its potential in revolutionizing the digital advertising sector. Blockchain since its inception has gained immense popularity owing to its successful implementation in the form of Bitcoin. Much of the focus thus has been primarily limited to the financial sector. However, in recent times, blockchain technology has been extensively explored to ascertain its potential in several other sectors, digital advertising is a significant one. Implementation of blockchain in digital advertising is believed to have a positive impact as it allows to reduce the cost and increase the trust by alleviating the need for any middlemen when compared to the conventional advertising strategies

7. Future Work

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Blockchain is an emerging field that holds significant promise in both financial and nonfinancial sectors. The application of blockchain seems to be noteworthy in the field that traditionally involved third parties to validate a transaction or a contract so that trust is enhanced. In this regard, Atzori (2015) believed that blockchain possessed the ability to usher in a change in both politics and the structure of the entire society. The introduction of blockchain in multiple sectors could result in the obsoletion of many centralized platforms thus making the system more transparent and trustworthy. In the concluding remarks, he opined that ‘‘decentralization of government services through permissioned blockchains is possible and desirable since it can significantly increase public administration functionality’’.

In the digital advertising sector blockchain technology has been a new entrant. Numerous articles have indicated the positive impact of blockchain in the advertising sector by reducing the cost, a number of fraud events and increased trust but yet detailed studies have been in this regard has been limited. Thus future work should concentrate more on real case studies dealing with the implementation of blockchain technology in the digital advertising sector. This would help fathom the feasibility of the technology application on a large scale.

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