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Blokzincir Teknolojisinin Sürdürülebilir Kalkınma Bağlamında Etkileri Üzerine Bir Tartışma

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Anahtar Sözcükler
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Öz

Güvenli, şeffaf ve merkezi olmayan bir veri yönetimi altyapısı sunan blokzincir teknolojisinin mümkün kıldığı çözümler ve kullanımı hızla yaygınlaşan kripto varlıklar, birçok endüstrinin dinamiklerini değiştirmektedir. Çok fazla endüstride tetiklediği yapıcı yıkım ve enerji tüketimi ile tartışma konusu olan blokzincir teknolojisi aynı zamanda sürdürülebilirliğe hizmet eden küresel ve kapsayıcı bir vizyon sunmaktadır. Bu makalede, nüfus artışının ve ekonomik büyümenin en yüksek oranda gerçekleştiği Antroposen çağının en yeni teknolojilerinden biri olan blokzincir teknolojisinin sürdürülebilir kalkınmanın üç ana alanı olan çevre, ekonomi ve topluma etkileri üzerine bir tartışma sunulmaktadır. Blokzincir teknolojisinin, bu üç temel alan üzerinde olumlu ve olumsuz etkileri olduğu söylenebilir. Sürdürülebilir toplum odağında kollektif değer yaratma ve sosyal etki projelerini destekleme imkânı sunan teknoloji, verilerin demokratik yönetimine de imkân vermektedir. Sürdürülebilir ekonomi odağında yeni iş modellerinin gelişmesine ve çok kısa sürelerde aracısız, limitsiz, düşük maliyetli bir sistem ile kripto paraların transfer edilmesine olanak sağlayan blokzincir teknolojisi finansal kapsayıcılığı artırmaya adaydır. İş kanıtı yöntemi ile çalışan blokzincirler yüksek enerji tüketimi ile çevreye zarar verme potansiyeli taşırken, farklı yöntemlerle çalışan blokzincirler enerji tüketimini düşürebilmektedir. Aynı zamanda yenilenebilir enerji kaynaklarının madencilikte kullanımını artıracak çalışmalar da bir yandan devam etmekte ve bu teknolojinin sürdürülebilir çevre odağındaki olumsuz etkilerinin ortadan kaldırılabileceği öngörülmektedir.

A Discussion on the Effects of Blockchain Technology within the Context of the Sustainable Development

Keywords
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Abstract

The solutions made possible by blockchain technology, and crypto assets, are changing the dynamics of many industries. Blockchain technology, which is the subject of discussion with the constructive destruction and energy consumption it triggers, offers a global and inclusive vision that serves sustainability. In this article, a discussion is presented on the effects of blockchain technology, on the environment, economy and society, which are the three main areas of sustainable development. It can be said that blockchain technology has positive and negative effects on these three main areas. Providing the opportunity to create collective value and support social impact projects with a focus on sustainable society, this technology also enables the democratic management of data. Blockchain technology, which allows the development of new business models with a focus on sustainable economy, has the potential to increase financial inclusion. While blockchains working with proof-of-work method have the potential to harm the environment with high energy consumption, blockchains working with different methods can reduce energy consumption. At the same time, studies that will increase the use of renewable energy resources in mining continue, and it is foreseen that the negative effects of this technology on the sustainable environment can be eliminated.

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Introduction

The anthropocene age, the geological period we are in, focuses on the effects of human activities on ecology (Steffen, Crutzen, & McNeill, 2007). From the perspective of Crutzen, who has coined the term “anthropocene” for the first time (Crutzen, 2006), this period started with the industrial revolution and was triggered by developments in technology. The anthropocene is the period in which the energy consumption increases drastically, and population growth and economic growth occur at the highest rate (Steffen et al., 2007). The first of the industrial revolutions of this period started with the transition from manual business and production methods to mechanical power with the use of fossil fuels in the 1800’s. The population, which has reached to 1 billion in the history of modern humanity until the first industrial revolution, started to increase rapidly with the ongoing industrial revolutions. The increasing population and the increase in production and consumption in the globalizing world emerged as anthropocene effects. While this transformation supported the increase of the quality of life of people, it was replaced by the second industrial revolution triggered by electrification towards the end of the 19th century. Wired and wireless communication, new generation power forms, and the start of mass production took place during this second revolution. The third industrial revolution that started in the 1950’s prepared the infrastructure for the transition to the fourth industrial revolution with the involvement of digital technologies in production, flexible production and data production. Today, we are in the fourth industrial revolution called industry 4.0. Industry 4.0 is a manifestation of the idea of deploying systems and features discovered in previous revolutions into many business activities such as management, production, supply chain, accounting, and human resources (Kaygın, Zengin, & Topçuoğlu, 2019). The combination of robot technologies, the internet of things, cloud storage technologies, blockchain technology, radio frequency identification, and many other technological advances has been expressed as the 'Fourth Industrial Revolution’ (Kaygın et al., 2019).The fourth industrial revolution is the period in which productivity and production increased with the use of a large number of physical and digital technologies.In this period, scientific point to the relationship between the development and prosperity of societies and the increase in air pollution and damage to the environment (Nakicenovic, Rockström, Gaffney, & Zimm, 2016).

The transformation era that we are living in today is characterized by the concept of smart and connected products as well as the change in main business processes. Technology-supported automated systems and devices communicate with each other by exchanging data over the internet. In addition to industrial production, this era has also accelerated the production in the digital world with newly developing digital platforms and mediums. While this situation transformed the dynamics of most industries, it enabled the economy to develop in these new areas. Technical and technological developments, and increased productivity in production are among the main reasons of the large-scale and historical economic growth, especially in the 20th century (Martine & Alves, 2015). New technologies made economic transformation possible (Cohen, Amorós, & Lundyd, 2017). While the Industry 4.0 era, in which the creation of new industries such as data science, platform-based business models, digital content production, and the incorporation of many other new business lines into the economy brought about economic growth at the historical level. With the increasing interaction of the society with information and communication technologies, the transition from the industrial society to the information society took place within this period. The information society "defines the information itself or the societies where the

activities for the production, processing, distribution of information are accepted as the main input and power source in economic, political, social and cultural fields" (BTK, 2017). In addition to being a new type of society, information society is a multidimensional phenomenon that includes the transformation that occurs with the use of knowledge by the society in almost every field. Technology and technology products, which are the main elements in this phenomenon, realize the transformation triggered by the machines in the industrial society. The effects of information society and technology products trigger important transformations on the environment, society and economy. While especially the globalization of data feeds the social and economic transformation, together with the increase of the amount of the data produced, the governance of the data is the challenge. Blockchain technology offers a secure, transparent, and decentralized data management infrastructure. As it is one of the newst technologies of this era, while it expands rapidly over different industries, the potential of this technology as well as the possible negative effects needs to be discussed for improvement. This article presents a discussion of the effects of the blockchain technology within the context of three pillars of sustainability and aims to contribute to the field with an interdisciplinary approach.

Method

Knowledge production regardless of the dicipline, enables to access the collective evidence. Especially an interdiciplinary overview of the new areas, provides the necessary knowledge production for further researches. Semi-systematic review approach is used to map theoretical approaches together with practical knowledge produced to identify knowledge gaps within the literature. As the aim of this article is to provide an overview of the effects of the blockchain technology on different areas like economy, society, and environment, a literature review is conducted to evaluate the state of knowledge as well as to discuss the theoretical approaches from different diciplines. The findings of this research will be base for the future researches on the blockchain technology and its effects realised on sustainable development. As the technology is mostly the topic for engineering related sciences, a social review of the technology and its effects would be providing knowledge fort he researches from different fields. The findings of the literatüre review will be discussed over three main areas within the article in order to sythesize the state of knowledge.

Literature Review

Sustainable Development

The anthropocene age, which has important effects on the environment, society, and economy is the period when the concept of sustainability started to be discussed in the academic literature. The concept of sustainability, which means the protection of the environment and sustaining economic growth for the future is defined by the World Environment and Development Commission (WCED) as “development that meets today's needs without compromising the ability of future generations to meet their own needs” (Thomsen, 2013). Researches on sustainability used to focus on the environment until the late 1900’s, however by 2000’s sustainability studies considers the economical, social and environmental aspects while incorporating the business aspects of risk management, transparency, strategy and culture (Kotob, 2011). Sustainability generally refers to three main areas: environment, society, and economy. When necessary importance is given to these three areas

simultaneously, sustainability can be achieved in a real sense (Gedik, 2020). This approach has brought the traditional and old economy-oriented development approach to a new dimension while creating a system of thinking that foresees an economic development in parallel with environmental and social development. This approach has also led to the development of a new relationship between people and the world, between globalization and ecology, and between nation states and the biosphere (Waters et al., 2016).

Sustainability refers to an approach that maximizes the protection of the environment, supports social sustainability and maintains economic production while trying to achieve the balance. This interdisciplinary approach proposes to rethink the consumption of limited resources by alternative methods on the economic system. Although the early roots of the link between environmental and economic development date back to the 19th and 18th centuries, the modern understanding of the concept and its formal recognition at the global level began with the Stockholm Conference in Sweden in 1972 (Barral, 2012). The concept of sustainable development is based on three moral imperatives: meeting people's needs, ensuring social equality, and respecting environmental boundaries (Holden, Linnerud, & Banister, 2017). Sustainable development encompasses types of economic and social development that protect and improve the natural environment and social equity. Development at the focus of sustainable development includes social and economic development. The economic emphasis here is "not the economic growth itself, as discussed by ecological economist Herman Daly, but the well-being of humanity and qualitative improvement in revealing people's potential" (Diesendorf, 2000).

The global sustainable development agenda includes the Sustainable Development Goals (SDGs) approved by the United Nations (UN). At the Sustainable Development Summit on September 25, 2015, with the approval of 193 member states of the UN, “Global Goals for Sustainable Development” were determined to be realized until 2030 (UN, 2021). The SDGs, mostly referring to human rights and equality for the survival of the planet, are grouped under the total headings which are independent but at the same time interrelated with each other. The UN emphasizes the universality of all SDGs, taking into account the challenges of local adaptations, with a “country-specific approach to global goals” (Mensah, 2019). The SDGs are a universal call to action to eradicate poverty, protect our planet, and ensure peace and prosperity for all people (UN, 2021). With an inclusive agenda, the SDGs walk in a spirit of partnership and pragmatism, making the right choices today to sustainably improve life for future generations. Parallel to this vision, sustainability should be considered with a long-term thinking approach besides the short-term measures while considering the future which is being built dependent on technological developments. Many of the SDGs also point out technology and technology products on the way to their targeted solutions (UNDP Turkey, 2021). One of the relatively new technologies of the industry 4.0 era is blockchain technology and it can be discussed over the priority areas of focus within the context of the sustainable development approach and the SDGs.

Blockchain Technology

Blockchain is a technology that provides a secure, transparent digital ledger which allows data to be recorded and transferred in a time-stamped, encrypted, distributed structure, with an unchangeable manner over the internet. This technology was mentioned in 2008 for the first time after the published works by a writer named

Satoshi Nakamoto whose real identity is not yet known (Nakamoto, 2008). His article named “Bitcoin: A Peer-to- Peer Electronic Cash System” describes a system to transfer money which isindependent from the goverments and banks. This cryptographically produced digital money is named as Bitcoin and the enabling technology as blockchain by Nakamoto (2008). The system is designed as a decentralized network managing tasks collectively depending on the participants called as nodes to complete the transactions and save the records on the distributed ledger structure. Blockchain has been described by many researchers as a distributed, transparent, immutable and secure data management tool, where the reliability of transactions is verified by stakeholders in the network (Zheng, 2017; Glaser, 2017; Halpin & Piekarska, 2017). From a technical point of view, it would be correct to define blockchain technology as a combination of a distributed database, decentralized consensus mechanism, and cryptographic algorithms (Zhao, Fan, & Side, 2016). Together with its such specific features, blockchain technology supports reliable and transparent transactions through network-based computing rather than tracking and controlling people’s private data. Blockchain technology forms the basis of security for users through its decentralized distributed data structure (Narayanan & Clark, 2017). The World Economic Forum defines blockchain as a technology protocol that enables the direct exchange of data between two parties, without the need for an intermediary (WEF, 2021). Today information we use on the internet is managed by individuals or corporations running their own servers. Blockchain, on the other hand, is a highly innovative and liberal system that provides users with the opportunity to own the privacy of their data, identity, and digital assets involving everyone equally.

Blockchain technology is just as important for the 4th industrial revolution as the internet was for the 3rd industrial revolution. At its most fundamental level, there is widespread debate about the breadth and depth of the potential impact of blockchain technology on the information society, which offers an infrastructure that is new, decentralized and globally capable of transforming many existing processes in governance (Tapscott & Tapscott, 2016; Iansiti & Lakhani, 2017). According to the European Commission (EU), blockchain is "a fair and inclusive key to build a secure and democratic digital economy” (EU, 2020). Together with the internet, smart phones, and, technologies such as the internet of things, the world has become an interconnected society. The infrastructure of the information society is no more highways, railways or different physical transportation means just like the industrial society, but rather “consists of communication networks such as cable, broadband, digital television, optical fiber network, fax, e-mail” (Yeşilorman & Koç, 2014). With this definition, data and information tools are included among the production tools of the information society. Scientist Marshall McLuhan (1964), on the other hand, discusses the importance of the medium carrying the data with his theory of “medium is the message”. The view that tools will shape knowledge in information and communication technologies emphasizes a double-sided interaction. Blockchain being the latest data transmission tool offered by technology, enables the transmission of data and therefore information without being changed.

The second cryptocurrency produced after Bitcoin was developed on the Ethereum protocol. Ethereum is also the second blockchain protocol which was introduced in 2015. Ethereum blockchain includes smart contracts which makes it possible to produce cryptocurrencies on this network. Cryptocurrencies are cryptography based, mathematically encrypted digital currencies that are suitable for use in digital mediums (Güleç et al. 2018). There are 15.918 different cryptocurrencies traded globally on 446 exchanges. Bitcoin and Ethereum has a %60

dominance. (CMC, 2021) Those two cryptocurrencies that have the highest dominance depends on the consensus protocol namely proof of work. Proof of work is a form of cryptographic proof where the prover proves to the verifiers that an amount of computational effort has been expended. Proof-of-work also allows the decentralized blockchain network to come to consensus, or agree on things like account balances and the order of transactions to prevent users from double spending and to ensure that the blockchain is tremendously difficult to attack or manipulate. (Ethereum, 2021) Although this type of mechanism is still discussed as having the highest security for the blockchain, as a result of the consumed high energy compared with other types of blockchain mechanisms, it is also criticized for harming the environment.

Findings and Discussion

The impacts of blockchain technology and blockchain based products on the UN's sustainable development agenda can be discussed in the context of the three pillars of sustainability – environment, society, and economy. There are innovative blockchain applications that can help achieve socially and environmentally beneficial results by challenging existing business models while offering new opportunities for humanity (Adams, Kewell, & Parry, 2017) This concept is emphasized as “blockchain for good” of its emphasis on healing within the scope of UN’s SDGs. Blockchain studies, which can be the basis of the steps to be taken towards sustainable development, can be conceptualized within the definition of blockchain technology for good (Barral, 2012). The impacts of blockchain technology within the context of three pillars of sustainability are discussed respectively as environment, economy, and society.

The Environment

Environmental protection is an important obligation on the basis of leaving a livable world to future generations. In recent years, individuals, institutions, and governments have taken initiatives on the protection of the environment on a global scale. While sensitivity increases regarding the environmental friendliness of products and production methods, traceability is therefore needed in many different industries. Blockchain technology is used in different sectors today and provides security and transparency by allowing a decentralized distribution of the common database where the transaction records between users are kept. The main element of every blockchain application is the collaboration protocol about sharing, repeating and disseminating information about transactions between participants (Viriyasitavat & Hoonsopon, 2018). Trust is an essential element of relational architecture; “without an element of trust, collaborative alliances can neither be built nor maintained” (Fawcett & Jones, 2013). Developed from this perspective, blockchain technology is integrated into business processes as a fundamental component in establishing security, distribution, openness, cost effectiveness, and most importantly trust. With the application of modern technologies, the innovative business process called industry 4.0; sees collaboration, automation, increasing the level of trust and transparency as the ultimate goal (Viriyasitavat & Hoonsopon, 2018). One of the most important effects of the blockchain architecture is that it eliminates the need for intermediaries in the focus of trust, as backward transactions cannot be performed on the blockchain and past transactions cannot be changed after they are approved. Untrusted or semi-trusted parties can interact with each other directly and transparently without the presence of a trusted intermediary on the blockchain networks (Bano et al., 2017). Blockchain technology, which provides advantages in terms of trust,

transparency, time, and cost compared to traditional central systems (Singhal, Dhameja, & Panda, 2018) enables to measure the results and performance of supply chain processes effectively.

"A development approach in which social and economic objectives are harmonized with ecologically sound foundations " was defined by Ignazy Sachs in 1978 with the term “eco-development” (Glaser, 2017). Although there are opinions that blockchain technology and applications will have important effects on the transformation of the energy industry through this approach, there is not enough research yet on the energy consumption of this technology (Li, Li, Haijiao, & Zhibin, 2018). The process that causes Bitcoin's energy consumption, called ' Bitcoin mining', is the process of validating transactions on the network by solving complex mathematical problems. Transactions performed in proof-of-work blockchains like Bitcoin are confirmed by the nodes that are connected to the network. As a result of the process that takes place as a block production every 10 minutes, the block reward is earned by the miners while a significant level of operating power and energy consumption occurs. Network participants who do the mining process earn Bitcoin by generating blocks in return for the transactions they solve (Nakamoto, 2008). While the first Bitcoin mining operations could be done with a computer with average features in 2009, the required processing power increased 4 times in 2019 compared to the previous year (Corbet, Lucey, & Yarovaya, 2019). Today, as the size of the chain has increased to approximately 330 GB (Statista, 2021) as a result of the increase in transactions in the Bitcoin blockchain, very high capacity computers are required for mining.

Bitcoin mining is costly and generates significant levels of waste (Gedik, 2020). Bitcoin produces 0.13% of the global carbon emissions, which is 37.2 billion tons annually, and 0.58% of the global electricity consumption (Johnson, 2021). Based on the average block time, minimum size of transactions, and maximum size of data provided by Evangelos Georgiadis, the amount of electricity consumed by Bitcoin is calculated as 60-125 TWh per year (Sedlmeir et al., 2021). Bitcoin's annual electricity consumption is over 115 TWh according to the statement made by the Cambridge Alternative Finance Center (2021) and 80 TWh according to the index of Digiconomist (2021). This amount of electricity consumption is equivalent to the annual electricity consumption of countries such as Austria (75 GWh) and Norway (125 GWh) (Sedlmeir et al., 2021). Bitcoin's energy consumption rate is easier to quantify than other financial instruments. With different financial transactions, Bitcoin's energy consumption has been observed to be higher or lower in different areas when compared to different financial transactions. According to a research result (Statista, 2021), the amount of energy consumed by one Bitcoin transaction is 910.19 kWh, while 100,000 Visa transactions consume 148.63 kWh of energy. According to another survey result, Bitcoin is much more efficient than traditional banking and gold mining on a global scale; traditional banking consumes 2.34 billion GJ and gold mining consumes 500 million GJ of energy per year (Elmandjra, 2020). Bitcoin consumes 184 million GJ, which is less than 10% and 40% of traditional banking and gold mining respectively (Elmandjra, 2020). However when the global-scale operations are calculated with the estimation method based on the energy consumption spent for a single Bitcoin transfer transaction, this amount of energy will cause a temperature to rise of 2 °C around the World (Sedlmeir et al., 2021). All these comparative values are in line with the discussions focused on the benefits of technology products for energy consumption and humanity. Today, an average of 46.45 % of the population worldwide uses smartphones (Statista, 2021) and smartphones consume significantly higher energy and produce a carbon

footprint compared to conventional home phones (IEEE, 2016). With the industrial revolutions, technology and societies have interacted and technology has been the trigger for the transformations for the development of humanity. Sometimes technology is so innovative and beneficial for humanity that its negative effects and positive benefits must be carefully discussed. Blockchain technology has also become a technology where significant investments continue to be made in many different sectors where it can generate added value, despite its energy consumption. Blockchain protocols, which are developed as an alternative to proof-of-work networks, aim to reduce this energy consumption. Miners also have turned to renewable energy sources with lower costs in recent years due to their increasing energy consumption. Even though the transition to renewable energy sources has begun in China, which is the country with the highest amount of mining today, still two-thirds of the energy consumed is from coal (Edie, 2021). However, efforts continue to increase the use of renewable energy sources in mining in a way that will reduce the energy consumption of blockchain technology and make it not harmful to nature (Johnson, 2021). For this purpose, a new global platform has been established and started its work. The platform named 'Crypto Climate Accord' carries out activities to make blockchain and crypto mining systems entirely with energy produced by renewable energy sources in order to reach a zero emission level by 2040 (Crypto Climate Accord, 2021). The first initiative of the formation, supported by the United Nations, against the climate crisis, is to do Bitcoin mining entirely with renewable energy sources in 2025 (Edie, 2021).

The Economy

The benefits of using blockchain technology for business and people are becoming apparent in social and environmental issues aimed at tackling global challenges such as financial inclusion (CPTM, 2016). Blockchain technology as embodied by the SDGs offers a progressive approach to increasing financial inclusiveness. Financial inclusion, which is at the heart of the G20 agenda, is an important enabler for many of the SDGs (OECD, 2021). Financial inclusion aims to increase the ability of individuals and companies to access key financial products and services, such as using financial services, taking advantage of business opportunities, insurance against risks, investing in education, and saving retirement (Seven et al., 2020) An inclusive financial system is the first step to financial development. There is a positive and strong relationship between access to financial services and economic development (Honohan, 2007). Blockchain technology allows cryptocurrencies to be transferred in a very short time, with no intermediary, unlimited, and at low-cost. While blockchain technology makes the transfer of small amounts of money economically possible and sustainable, it also allows new actors to join the ecosystem and expand e-commerce opportunities. (Adam et. al., 2017) Studies on the effects of blockchain technology in the field of economy show that the effects of this technology are not limited to the banking sector, but have the potential to reshape the economy (Nguyen, 2016). Today, the use of digital technologies and social media significantly change the dynamics of producers and consumers, but blockchain technology can provide financial solutions compatible with these transforming dynamics. According to the report by The World Bank (2021) on Earth 1.7 billion bank accounts without that there are people outside the traditional financial system. Half of the young population aged 15-24 are also excluded from financial inclusion (OECD, 2021) While the proportion of people excluded from the financial system in developing countries is around 80 percent, it is generally below 20 percent in developed countries. Inclusiveness, which focuses on accessing various services, opportunities, or opportunities equally, prevents some segments of the society from

using their potential, while also preventing them from contributing to economic growth. For this unbanked population, blockchain technology provides an alternative system. Especially since the early 2000s, financial inclusion has been one of the priority agendas on the agenda of institutions such as the World Bank, OECD and the United Nations, in both developed and developing countries, in order to reduce inequalities (The World Bank, 2021). The United Nations World Food Program is one of the organizations that have tried to use blockchain technology in transfers in order to reduce financial costs and increase access, especially for their work focused on refugees (Blockchainhub Berlin, 2018).

Financial inclusion can be discussed in both economic and social sustainability areas. Sustainable Development refers to the harmonization of the use of resources, investments, technological developments and transformations in a way that meets the needs of humanity and is sufficient for future generations. Fundamentally sustainable human development is critical when we consider both the economy and society. The basis of human development lies in the handling of the human phenomenon as a whole, that is, all individuals have equal rights without dividing them into groups according to their differences. In other words, widespread access to financial services is very important in an economy as well as the existence of developed financial markets for sustainable development.

Block chain technology are the very comes at the beginning of the interest payments systems and rapidly growing field of application. In the article describing the blockchain technology for the first time (Nakamoto, 2008). Bitcoin, which is the first of the alternative cryptocurrencies developed on the blockchain, independent of central banks and governments, is mentioned. Again, in the article, the infrastructure of the electronic money system that makes it possible to transfer between spouses is explained. Since the blockchain technology infrastructure can send money without a person-to-person brokerage, it has brought an alternative to the traditional financial system. Today, Bitcoin's market value has reached 1 Trillion USD. The total market value of 9548 different cryptocurrencies in the crypto money market is 2.3 Trillion USD (CMC, 2021). Fixed cryptocurrencies are preferred for payments and money transfers. The total market value of fixed cryptocurrencies with low price fluctuations and the majority of which are indexed to the US dollar is 95 billion dollars. Blockchain technology, which has a growing volume in financial markets, creates benefits based on financial inclusion in three main areas with its "potential to provide secure and fast data transfer for everyone". The first of these is that blockchain technology, which makes it possible to transfer between individuals by eliminating intermediaries and 3rd parties, can reduce the costs and times of money transfer. The second issue is that it makes it easier to have an account. While having a digital wallet is sufficient for crypto money transfers, the wallet opening process is completely digital. The process of having a wallet, which can only be completed with a mobile phone and ID, reduces geographical barriers and allows low-income individuals to have financial access, depending on the process of opening a bank account. The third issue is that blockchain technology can include individuals from different cultures and religions with a focus on transparency and reliability, which is the most important value proposition. Blockchain can provide an alternative solution, especially for the population who do not use banks for religious reasons.

The Society

Bitcoin offers an approach to creating a collective value without traditional intermediaries. Sustainable behavior can be encouraged with cryptocurrencies developed on smart contracts, which supports a sustainable future approach in the long term. Projects developed with a focus on social impact and the secure transfer of donations without intermediaries are also important added values. Coins produced for social impact are specially designed for investments made with the aim of contributing positively to social and environmental projects. Social impact cryptocurrencies have four main objectives: (Uzsoki & Guerdat, 2019) 1-Increasing trust between parties 2-Increasing financial and social inclusiveness 3-Improving data collection, monitoring, reporting, and approval processes 4- Rewarding behaviors that encourage sustainability. Social impact tokens, which are used to make existing systems more efficient by reducing intermediaries, and therefore bureaucracy and costs, can be transferred on blockchain. With these token, which ensure compliance with the rules by means of smart contracts, many different impact projects can be implemented and contribute to the SDGs. The 22 social impact token projects that have been implemented have provided digital evidence of impact investments in many different industries such as education, health, energy, and agriculture, enabling the monitoring of the outputs of these investments and increasing investments in the impact economy (Uzsoki & Guerdat, 2019). Traceability of aids, donations, and investments and ensuring that unmediated support reaches those in need can be counted among its important added values.

Bitcoin offers an approach to creating collective value without traditional intermediaries. Sustainable behavior can be encouraged with cryptocurrencies developed on smart contracts, which supports a sustainable future approach in the long term. There are very successful examples of environmentalist projects that reduce carbon footprint by using public transportation or bicycles to reduce carbon dioxide emissions, supporting recycling, reducing food waste, planting trees or cleaning beaches, that is toreward those who support natural resources (Blockchainhub Berlin, 2018).

Blockchain technology has started to have significant effects on social development and development by democratizing access to data and information. Blockchain technology has the potential to transform the internet from an information network to a value network (Adams et.al, 2017) Blockchain technology, which increases access to information in an inclusive and unmediated way, can offer artists, social media digital content producers, the game industry, the media, and many other industries by developing ecosystems without intermediaries, and offering new business models and economic models. In addition to democratization of access to information, with examples such as tracking of news content on the blockchain, social media channels working on the blockchain, it is also ensured that accurate and source-traceable information is delivered to the society.

The entities and objects tokenized, and valuable data can be transferred without intermediaries is made possible by blockchain technology. Tokenization of art works with non-fungible tokens (NFTs) on blochain has started a new art movement called as crypto art while creating a significant economic model. A total of 201 unique tokens have reached a market value of 32 Billion dollars, creating a serious economy in the art industry (CMC, 2021). The crypto art movement enables an artist to submit his work to the blockchain and give it directly to a collector

directly. The crypto artist digitally signs a work of art using crypto technology and can share it directly with many people (BTC News, 2021). Just like different blockchain based applications and use cases at different industries, blockchain eliminates the intermediaries and brings transparency to the art industry. Crypto art allows artists to bring their artworks existing in a digital world directly to buyers without intermediaries. And the artworks' contract addresses, transactions, ownerships, and history can be traced in a transparent way on-chain.

Conclusion

Blockchain technology is a new, detailed, and relatively complex technology, especially for non-digital researchers, which can reduce the depth of any research. Blockchain technology, which finds rapidly increasing usage areas, can be discussed over the positive and negative effects it has over sustainability through three main focus areas. Although there are thousands of cryptocurrency and blockchain-based projects produced for different purposes, the potential of those projects, which are still at an early stage, to produce results that support the sustainability approach should be monitored in the medium term and supported with research. In order to understand the benefits or challenges of technologies for humans, they must be considered in the context of dynamic interactions independent of the characteristics of the technology (Majchrzak & Markus, 2014). Early implementations of blockchain technology has started to distrup finance ecosystem and while challenging the conventional banks it has created a space for the unbanked population to be included within the global economy. From the society perspective, regardless of the financial inclusiveness, blockchain technology and crypto currencies courages sustainable behavior by automatic rewarding systems. As well, the technology comes with a solution for the royalty rights with its added value for the tracebility of any kind of data. The impact on art industry is the second big disruption of the technology as it enables tokenization or art work and exchanges without intermediaries. The early stage blockchain protocols that adopt proof of work mechanism challenges the environment dur to the high level of energy consumption. However the proof of stake mechanism of second generation blockchain protocols and the lower level of energy consumption is promising for this challenge. As well integration of reneweable energy sources as the resourse comes with an opportunity to utilize the unemployed resources as well less harm for the environment. There is a rapid and highly growing demand for cryptocurrencies and blockhain based decentralized application. In order to evaluate the results of those blockchain technology based projects, detailed researches on the dynamic relations of the projects in the axes of the environment, economy and society as well as the transformation effects of the sectors is necessary to be carried out continuously to allow comparison.

Extended Abstract

Giriş

İçinde bulunduğumuz jeolojik dönem olan antroposen çağı, ekoloji üzerinde insanların faaliyetlerinin etkilerine odaklanmaktadır (Steffen, 2007). Sanayi devrimi ile başlamış ve teknolojideki gelişmelerle tetiklenmiş olan bu çağ dünya üzerinde artan enerji tüketimi ile dengelerin değiştiği, nüfus artışı ve ekonomik büyümenin en yüksek oranda gerçekleştiği dönemdir. Bugün içinde olduğumuz dördüncü sanayi devrimi ile teknoloji destekli otomatize edilmiş sistemler ve cihazların birbirleri ile internet üzerinden veri alışverişi yaparak iletişim halinde üretim yaparken, toplumun bilgi iletişim teknolojileri ile etkileşiminin artmış sanayi toplumundan bilgi toplumuna geçiş yaşanmıştır. Bilgi toplumu ve teknoloji ürünlerinin bir sonucu olarak küresel ölçekte artan ve yönetişimi zorlaşan veri çevre, toplum ve ekonomi üzerinde önemli etkilere neden olmaktadır. Blokzincir teknolojisi güvenli, şeffaf ve merkezi olmayan bir veri yönetimi altyapısı sunar. Bu çağın en yeni teknolojilerinden biri olması ve farklı sektörlere hızla yayılmasına karşın, bu teknolojinin potansiyelinin ve olası olumsuz etkileri henüz detaylı araştırmalara konu olmamıştır. Bu makale, sürdürülebilir kalkınma bağlamında ekonomi, toplum ve çevre odağında blokzincir teknolojisinin etkilerinin bir tartışmasını sunmakta ve disiplinler arası bir yaklaşımla alana katkı sağlamayı amaçlamaktadır.

Yöntem

Yeni alanlara disiplinler arası bir bakış, daha sonraki araştırmalar için gerekli bilgi üretimini sağlar. Yarı sistematik inceleme yaklaşımı, literatürdeki bilgi boşluklarını belirlemek için üretilen pratik bilgilerle birlikte teorik yaklaşımları haritalamak için kullanılır. Bu makalenin amacı blokzincir teknolojisinin ekonomi, toplum ve çevre gibi farklı alanlardaki etkilerine genel bir bakış sağlamak olduğundan, bilgi durumunu değerlendirmek ve farklı kuramsal yaklaşımları tartışmak için yarı sistematik bir literatür taraması yapılmıştır. Bu araştırmanın bulguları bilgi durumunu sentezlemek için makale içerisinde üç ana alan üzerinden tartışılacaktır ve blokzincir teknolojisi ile bu teknolojinin sürdürülebilir kalkınma üzerindeki etkileri konusunda gelecekte yapılacak araştırmalara temel sağlayacaktır.

Literatür Tarama

Sürdürülebilir Kalkınma

Çevre, toplum ve ekonomi odağında önemli etkileri olan antroposen çağı, aynı eksende sürdürülebilirlik kavramının da literatürde tartışılmaya başladığı dönemdir. Çevrenin ve gelecek için ekonomik büyüme ve kalkınmanın korunması anlamına gelen sürdürülebilirlik kavramı, “gelecek nesillerin kendi ihtiyaçlarını karşılama yeteneklerinden ödün vermeden, bugünün ihtiyaçlarını karşılayan kalkınma” olarak tanımlanmaktadır (Thomsen, 2013). Bu disiplinlerarası yaklaşım, kısıtlı kaynakların alternatif yöntemlerle tüketimini ekonomik sistem üzerinde yeniden düşünmeyi önerir. Küresel sürdürülebilir kalkınma gündemi, Birleşmiş Milletler (BM) tarafından onaylanan Sürdürülebilir Kalkınma Amaçları’nı (SKA) içermektedir. Endüstri 4.0 erasının nispeten en yeni teknolojilerinden olan blokzincir teknolojisi sürdürülebilir kalkınma yaklaşımı bağlamında değerlendirildiğinde SKA’lar odağında olumlu ve olumsuz etkileri üzerinden tartışılabilmektedir.

Blokzincir Teknolojisi

Blokzincir, verilerin internet üzerinden zaman damgalı olarak, dağıtık bir yapıda, şifrelenerek, değiştirilemez bir şekilde kaydedilmesine ve transfer edilmesine imkân veren, güvenli, şeffaf bir dijital işlem defteri sağlayan teknolojidir. Blokzincir sistemi ilk kez gerçek kimliği henüz bilinmeyen Satoshi Nakamoto (2008) isimli bir yazarın 2008 yılında yayınladığı "Bitcoin: A Peer-to-Peer Electronic Cash System" adlı makalesinde tariflenmiştir. Bitcoin, blokzincir üzerinde geliştirilen, merkez bankaları ve hükümetlerden bağımsız alternatif ödeme aracı olarak tasarlanmıştır. Yine makalede eşler arasında transfer gerçekleşmesini mümkün kılan elektronik para sisteminin altyapısı açıklanmıştır. Nakamoto' ya (2008) göre blokzincir, yapılan her işlem bilgisinin ağdaki işlemleri çözen, kontrol eden ve onaylayan düğüm adı verilen katılımcılar tarafından kaydedildiği ve paylaşıldığı dağıtık bir veri yönetim defteri yapısıdır. Blokzincir birçok araştırmacı tarafından işlemlerin güvenirliğinin ağdaki paydaşlar tarafından doğrulandığı dağıtılmış, şeffaf, değiştirilemez ve güvenli bir veri yapısı ve veri yönetim aracı olarak tanımlanmıştır (Zheng, 2017; Glaser, 2017; Halpin, & Piekarska, 2017). Bitcoin'den sonra üretilen ikinci kripto para birimi, Ethereum protokolünde geliştirilmiştir. Ethereum blokzinciri, bu ağ üzerinde kripto para üretmeyi mümkün kılan akıllı sözleşmeleri içerir. (Güleç et. Al., 2018). Ethereum ile hızla artmaya başlamış olan kripto para adetleri bugün 15.918'e ulaşmıştır. (CMC, 2021) Bu adet içerisinde Bitcoin ve Ethereum %60 pazar payına sahiptir. (CMC, 2021) En yüksek paya sahip olan bu iki kripto para birimi, fikir birliği protokolü olarak iş kanıtı yönteine dayalı çalışmaktadır. İş kanıtı, merkezi olmayan blok zinciri ağının fikir birliğine varmasına veya hesap bakiyeleri ve kullanıcıların çift harcama yapmasını önlemek ve blok zincirine saldırmanın veya manipüle etmenin son derece zor olmasını sağlamak için işlem sırası gibi şeyler üzerinde anlaşmaya izin verir. (Ethereum, 2021) Bu tür bir mekanizma hala blokzincir için en yüksek güvenliğe sahip olarak tartışılsa da diğer blokzincir mekanizmalarına kıyasla tüketilen yüksek enerjinin bir sonucu olarak, çevreye zarar verdiği için de eleştirilmektedir.

Bulgular ve Tartışma

Blokzicir Teknolojisinin Sürdürülebilirlik Bağlamında Etkileri

Blokzincir teknolojisi ve bu teknolojinin altyapısı olduğu ürünlerin BM'in sürdürülebilir kalkınma gündemine etkileri, sürdürülebilirliğin odaklandığı çevre, toplum ve ekonomi bağlamında sırası ile bu bölümde tartışılmaktadır.

Çevre

Bitcoin'in enerji tüketimine neden olan ve 'Bitcoin madenciliği' adı verilen işlem, karmaşık matematik problemleri çözerek, ağdaki işlemlerin onaylanması sürecidir. Bitcoin madenciliği yüksek maliyetlidir ve ciddi seviyede atık üretir (Gedik, 2020). Bitcoin yıllık 37.2 milyar ton olan global karbon emisyonunun %0.13'ünü üretmektedir ve global elektrik tüketiminin ise %0.58'ini oluşturmaktadır (Johnson, 2021). Yıllık 60 ila 125 TWh arasında bir değer olarak hesaplanan elektrik tüketim miktarı, Avusturya (75 GWh) ve Norveç (125 GWH) gibi ülkelerin yıllık tüketim miktarı ile eşdeğerdir (Sedlmeir et al., 2020). Alternatif olarak geliştirilen hisse ispatı ya da farklı yöntemlerle çalışan blokzincir protokolleri bu enerji tüketimini düşürmeyi hedeflemektedir. Blokzincir teknolojisinin enerji tüketimini azaltacak ve doğaya zarar vermeyecek hale getirecek şekilde

yenilenebilir enerji kaynaklarının madencilikte kullanımını artıracak çalışmalar da bir yandan devam etmektedir (Johnson, 2021). Birleşmiş Milletler tarafından desteklenen 'Crypto Climate Accord' isimli platformun önderliğinde 2025 yılında Bitcoin madenciliğinin tamamen yenilenebilir enerji kaynakları ile yapılması hedeflenmektedir (Edie, 2021).

Ekonomi

Blokzincir teknolojisin en cok ilgi çeken ve hızla büyüyen uygulama alanlarının başında ödeme sistemleri gelmektedir. Blokzincir teknolojisi çok kısa sürelerde, aracısız, limitsiz ve düşük maliyetli bir sistem ile kripto paraların transfer edilmesine olanak sağlamaktadır. Finansal piyasalarda büyüyen bir hacme sahip olan blokzincir teknolojisi, sahip olduğu "herkes için güvenli ve hızlı veri transferi sağlama potansiyeli" ile 3 temel alanda finansal kapsayıcılık odaklı fayda yaratmaktadır. Bunlardan ilki aracıları ve 3. partileri aradan çıkartarak bireyler arası transferi mümkün kılan blokzincir teknolojisinin para transfer maliyetlerini ve sürelerini düşürebiliyor olmasıdır. İkinci konu, hesap sahibi olma imkanını kolaylaştırmasıdır. Dijital cüzdan sahibi olma süreci banka hesabı açma sürecine göre başta coğrafi engelleri azaltmakta ve düşük gelirli bireylerin finansal erişimine imkân vermektedir. Üçüncü konu ise, blokzincir teknolojisinin en önemli değer önermesi olan şeffaflık ve güvenirlilik odağında, farklı kültürlerden ve dinlerden bireyleri kapsayabiliyor olmasıdır.

Toplum

Bitcoin geleneksel aracılar olmadan kollektif değer yaratma hususunda bir yaklaşım sunmaktadır. Akıllı kontratlar üzerinde geliştirilen kripto paralar ile sürdürülebilir davranışlar teşvik edilebilmektedir ve bu da uzun vadede sürdürülebilir bir gelecek yaklaşımını desteklemektedir. Sosyal etki amaçlı üretilen kripto paralar, toplumsal ve çevresel projelere pozitif katkı sağlamak amacı ile yapılan yatırımlara özel olarak tasarlanmaktadır. Hayata geçmiş olan 22 sosyal etki token projesi, eğitim, sağlık, enerji ve tarım gibi çok farklı sektörlerde etki yatırımlarının dijital kanıtlarını sağlayarak bu yatırımların çıktılarının takip edilmesini sağlamış ve etki ekonomisine yatırımların artmasını sağlamıştır (Uzsoki & Guerdat, 2019).

Blokzincir teknolojisinin verilere ve bilgiye erişimi demokratikleştirerek interneti bilgi ağından değer ağına dönüştürme potansiyeli bulunmaktadır (Adams et al., 2017). Bilgiye erişimi kapsayıcı ve aracısız bir şekilde artıran blokzincir teknolojisi, sanatçılara, sosyal medya dijital içerik üreticilerine, oyun sektörüne, medyaya ve benzeri birçok endüstriye aracıların olmadığı ekosistemler geliştirilerek, yeni iş modelleri ve ekonomik modeller sunabilmektedir. Varlıkların ve nesnelerin tokenize edilmesi ve değerlerin aracısız transfer edilebilmesi blokzincir teknolojisi ile mümkün kılınmaktadır.

Sonuç

Blokzincir teknolojisinin yeni, detaylı ve özellikle sayısal bilimler kökenli olmayan araştırmacılar için nispeten karmaşık olması yapılan araştırmaların derinliğini azaltabilmektedir. Hızla artan kullanım alanları bulan blokzincir teknolojisinin, sürdürülebilirliğin üç temel odağı üzerinde olumlu ve olumsuz etkileri olduğu söylenebilir. Farklı amaçlar için üretilmiş binlerce kripto para ve blokzincir tabanlı proje olmasına rağmen henüz erken aşama olan bu projelerin sürdürülebilirlik yaklaşımını destekleyen sonuçlar üretme potansiyeli orta vadede takip edilerek araştırmalarla desteklenmelidir.

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