LA TECNOLOGIA BLOCKCHAIN Y LOS OBJETIVOS DE DESARROLLO SOSTENIBLE

BLOCKCHAIN TECHNOLOGY AND THE SUSTAINABLE DEVELOPMENT GOALS

Cite as: Guede-Tejedor, M., Chalmeta, R. (2022). BLOCKCHAIN TECHNOLOGY AND SUSTAINABLE DEVELOPMENT GOALS. DYNA, 97(6). 594-598. DOI: https://doi.org/10.6036/10549

Maite Guede Tejedor, Ricardo Chalmeta

Systems Integration and Re-Engineering Group (IRIS). Departamento de Lenguajes y Sistemas Informáticos. Universidad Jaume I. Av Sos Baynat s/n.12071 Castellón de la Plana. Spain

Recibido: DD/MM/AA – Revisado: DD/MM/AA -- Aceptado: DD/MM/AA - DOI: https://dx.doi.org/10.6036(A cumplimentar por el Editor)

ABSTRACT:

Blockchain (BC) is an emerging technology from the Fourth Industrial Revolution that has the potential to be applied to different sectors and address issues related to sustainability. However, research on Blockchain has tended to focus on its technical characteristics, with no studies analyzing its positive and negative impact on sustainability.

This article presents an analysis of how this technology can help to achieve each one of the different Sustainable Development Goals (SDGs), along with a series of case examples that can serve as a model; as well as an identification of the negative impacts that the Blockchain has for sustainability.

The findings of this study are useful for engineers, since they identify the technological aspects of BC that need to be improved; for company managers, since they can appreciate the positive impact that this new technology could have on sustainability if it is applied correctly; and for politicians, to whom it poses a series of challenges and the need to carry out regulatory reforms.

Key Words: Blockchain, Distributed Data Bases, Sustainable Development Goals (SDGs), Industry 4.0, Sustainability

RESUMEN:

Blockchain (BC) es una tecnología informática emergente que tiene el potencial de aplicarse a diferentes sectores y abordar cuestiones relacionadas con la sostenibilidad. Sin embargo, la investigación en Blockchain ha tendido a centrarse en sus características técnicas, no habiéndose realizado estudios que analicen su impacto positivo y negativo en la sostenibilidad.

Este artículo presenta (1) un análisis de cómo esta tecnología puede ayudar a alcanzar cada uno de los diferentes Objetivos de Desarrollo Sostenible (SDG), junto con una serie de casos de ejemplo que pueden servir de modelo; y (2) una identificación de los impactos negativos que el Blockchain tiene para la sostenibilidad.

Los resultados de este estudio son útiles para los ingenieros, ya que identifica los aspectos tecnológicos del BC que son necesario mejorar; para los gestores de empresa, ya que pueden apreciar el impacto positivo que para la sostenibilidad podría tener esta nueva tecnología de ser aplicada correctamente; y para los políticos, a los que les plantea una serie de desafíos y la necesidad llevar a cabo reformas normativas.

Palabras Clave: Blockchain, Bases de datos distribuidas, Objetivos de Desarrollo Sostenible (SDG), Industria 4.0, Sostenibilidad

ISSN: 0012-7361 eISSN: 1989-1490 / DYNA Vol.XX nºX DOI: https://doi.org/10.6036/XXXX

1. INTRODUCCION

One of society's greatest challenges is to achieve sustainable development, which is defined as development that meets the needs of the present without compromising the ability of future generations to meet their needs. To achieve this development, the United Nations (UN) in 2015 launched the 2030 Agenda composed of 17 Sustainable Development Goals (SDGs).

A key factor in achieving the 17 Sustainable Development Goals is innovation since it is useful for improving people's quality of life and current forms of production and consumption. It is therefore interesting to study how new technologies can be applied to sustainability and the advantages and/or disadvantages of doing so.

One of the new disruptive information technologies that has the greatest potential to achieve the SDGs is the Blockchain (BC) [1]. BC technology is a form of decentralized, reliable, and hardly fraudulent database storage that makes it possible to exchange digital assets securely and efficiently and can be applied to different sectors [2; 3]. The main objective of this technology is to eliminate intermediaries by replacing them with a distributed network of digital users that verify transactions and safeguard the integrity of the records. The SDGs, due to its technical characteristics, can guarantee trust even between unknown entities or participants, which encourages collaborative economy, peer-to-peer transactions, circular economy and other ways of doing economy that could be more sustainable.

The multiple applications of this technology may represent a breakthrough for sustainable development, as it could help address problems associated with climate change, increase access to finance for the poorest people and partially eliminate corruption, among other aspects. However, there are barriers and negative consequences of implementing the Blockchain, such as the depletion of energy resources, which could mean a setback in the progress made in recent years towards sustainability.

To date, BC research has tended to focus on its technical characteristics and little thought has been given to the potential socially and environmentally beneficial use cases that Blockchain technology could have [4], so the full potential it must contribute to the SDGs and thus to sustainable development is not yet known [1].

This study aims to advance the state of the art on Blockchain and sustainability by conducting an analysis of the positive and negative aspects of applying BC for the achievement of the SDGs, along with an identification of different case examples of how Blockchain can be used to achieve each of the different SDGs. The results point out that the advantages of applying this technology outweigh the disadvantages, as the problems generated by the implementation of BC can be mostly solved. These results are important because they show that BC has the potential to be applied to various sectors that could contribute to sustainable development.

2. BACKGROUND

2.1 THE BLOCKCHAIN TECHNOLOGY

Blockchain is one of the existing technologies to implement a distributed database of records or a distributed ledger. A distributed ledger, or DLT (Distributed Ledger Technology), is a decentralized repository of data managed and maintained by multiple participants. In general, the participants have equal rights, control over the repository, and communicate directly with each other to propose and notify updates to the repository. Therefore, there is no need for intermediaries or a centralized controller, as the participants use a distributed consensus algorithm to decide on which updates to make [5].

Therefore, the Blockchain (BC) is a way in which technology replaces intermediaries or trusted third parties. An internet user can register and transfer -or share- a digital unit to another user or to a community guaranteeing that the transfer is secure and transparent, due to the fact that the rest of the users can verify and validate that the transfer has really taken place, thus accepting new updates to the distributed ledger [6]. In turn, the Blockchain contains a secure and verifiable record of each of the transactions carried out, since the integrity of the data set is reinforced through cryptography and complex algorithms [7; 8].

Broadly speaking, the result is a large database that instead of being managed by one entity is managed by a plurality of entities operating as peers, providing a record that is difficult to manipulate as it is immutable, verifiable, and encrypts user identities (United Nations Development Program UNDP, 2019). Therefore, this technology has the potential to revolutionize the digital world by enabling a distributed consensus in which all online transactions involving digital assets can be verified at any time without compromising the privacy of the parties involved [9].

In 2018, the World Economic Forum defined Blockchain as the first technological trend worldwide. In fact, as can be seen in Figure 1, interest in this technology has been exponential, especially until the end of 2017 when it found its peak.

ISSN: 0012-7361 eISSN: 1989-1490 / DYNA Vol.XX nºX DOI: https://doi.org/10.6036/XXXX

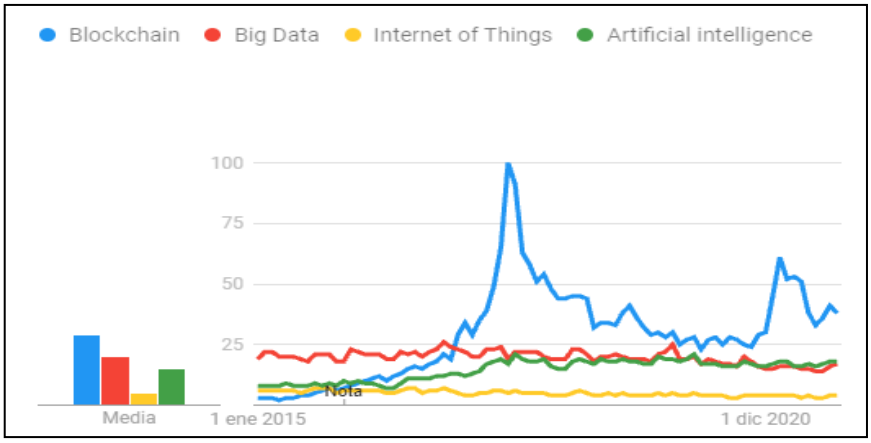

Figure 1: Interest in new disruptive computing technologies globally (2015 - 2021).

Appendix I (see supplementary material on Dyna's website) explains in more detail how the Blockchain works, its characteristics, and the types of Blockchain platforms.

2.2 SUSTAINABLE DEVELOPMENT GOALS

The SDGs are a universal call to action to end poverty, protect the planet and improve the lives and prospects of people around the world. In 2015, the Member States of the United Nations adopted the 2030 Agenda for Sustainable Development. That agenda includes 17 goals, called Sustainable Development Goals, and 169 targets aimed at solving the social, economic, and environmental problems affecting the world by 2030 [10].

One of the main differences between the SDGs and their predecessors, the Millennium Development Goals (MDGs), is that they are universal since all countries have global and national obligations. It is also multi-stakeholder, as it points out the need for the participation of all actors in society: governments, the private sector, civil society and the people as a whole in order to achieve the Agenda's objectives.

On the other hand, the goals are interrelated and therefore indivisible. It is not possible to achieve only one SDG without positively or negatively impacting another, and likewise, to achieve sustainable development, all 17 goals must be met, as each of them represents the present and future needs of people and the planet.

The SDGs are not legally binding. However, governments are expected to adopt them as their own and establish frameworks, policies, and measures at the national level for their implementation and achievement [10]. Table 1 shows the 17 SDGs.

SDG 1: No poverty. End poverty in all its forms everywhere.	**SDG 10: Reduced inequalities.** Reduce inequality within and between countries.
SDG 2: Zero hunger. End hunger, achieve food security and improved nutrition, and promote sustainable agriculture.	**SDG 11: Sustainable Cities and Communities** Make cities and human settlements inclusive, safe, resilient, and sustainable.
SDG 3: Good health and well-being. Ensure healthy lives and promote well-being for all at all ages.	**SDG 12: Responsible consumption and production.** Ensure sustainable consumption and production patterns.
SDG 4: Quality education. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.	**SDG 13: Climate action.** Take urgent action to combat climate change
SDG 5: Gender Equality. Achieve gender equality and empower all women and girls.	**SDG 14: Life below water.** Conserve and sustainably use the oceans, seas, and marine resources for sustainable development.

ISSN: 0012-7361 eISSN: 1989-1490 / DYNA Vol.XX nºX DOI: https://doi.org/10.6036/XXXX

SDG 6: Clean water and sanitation. Ensure availability and sustainable management of water and sanitation for all.	**SDG 15: Life on land.** Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation and halt biodiversity loss
SDG 7: Affordable and clean energy. Ensure access to affordable, secure, sustainable, and modern energy for all.	**SDG 16: Peace, justice and strong institutions.** Promote just, peaceful and inclusive societies for sustainable development, provide all people with access to justice, and develop effective, accountable and inclusive institutions at all levels effective and inclusive institutions that are accountable.
SDG 8: Decent work and economic growth. Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all.	**SDG 17: Partnership for goals.** Strengthen the capacities for implementation and revitalise the Global Partnership for Sustainable Development.
SDG 9: Industry, Innovation and infrastructure. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.	

Table 1: The Sustainable Development Goals (SDGs)

3. 3. IMPACT OF BLOCKCHAIN TECHNOLOGY ON THE SDGs

3.1. POSITIVE IMPACT OF THE BLOCKCHAIN TO THE SDGs. CASES OF EXAMPLE

BC technology has the potential to be a disruptive innovation that can provide solutions to different problems and needs associated with sustainable development and be an accelerator for meeting the SDGs due to its multiple applications. Table 2 shows how BC can contribute to achieving each of the SDGs, along with some example cases that can serve as a model for future developments.

SDG	IMPACT	EXAMPLE CASE	SDG	IMPACT	EXAMPLE CASE
	Promoting microfinance (Target 1.4) by facilitating access and reducing transaction costs.	Trusted Lending Circles: Peer-to-peer lending application.		Reducing the transaction costs of migrant remittances (target 10.c).	HK-Philippines Cross-Border Remittance Project: Improving the speed, efficiency, security and transparency of cross-border remittances between Hong Kong and the Philippines
	Increasing agricultural productivity and incomes of small-scale food producers (Target 2.3) by providing coverage against weather patterns.	Etherisc: Insurance that takes weather conditions into account.		Increasing resilience to climate change (Target 11.5).	Active Citizen in Moscow: citizen participation to develop the city according to the needs of its inhabitants.
	Creating a single clinical record compatible among different institutions and	Patientory: platform for storing, managing and transferring private health information.		Promoting the collaborative economy and thus reducing waste generation	La'Zooz: application that encourages peer-to-peer car sharing.

ISSN: 0012-7361 eISSN: 1989-1490 / DYNA Vol.XX nºX DOI: https://doi.org/10.6036/XXXX

	territories (Goal 3.8).			and emissions (Target 12.5).	
	Providing decentralized educational records (Goal 4.a and 4.b)	ODEM: Decentralized educational platform.		Providing transparency in carbon emission data and an efficient and transparent market infrastructure for carbon trading.	Everledger: real-time emission measurement.
	Providing women with access to secure financial resources (Goal 5.a) through digital wallets and transfers	Vipicash is an application that allows you to transfer and control your money.		Ocean conservation through a plastic market (Target 14.1). Reducing illegal fishing through supply chain traceability (Target 14.4 and 14.b).	Plastic Bank: ethical recycling ecosystems in coastal communities that reintroduce recycled plastic into the global industry. Pacifical MSC Sustainable Tuna Blockchain: sustainable tuna fishing in Oceania.
	Promote water use efficiency through water control, management and peer-to-peer water surplus trading	Kilimo is an application that issues smart certificates verifying efficient irrigation management.		Target 15.2 Cryptocurrency to invest in habitat restoration and species conservation.	Live Lebanon (UNDP): Impact Investing Initiative
	Facilitating access to energy (Target 7.1) through peer-to-peer renewable energy exchange systems Providing security to the information provided about energy and thus controlling its use (Target 7.2).	The Sun Exchange: application to sell solar energy among peers. Greenergie: application that helps users to understand their energy consumption and to reduce it.		Providing a legal identity to all people through digital identity documents (Target 16.9). Reducing corruption through transparent records (Target 16.5).	The World Food Program (WFP) provides food assistance to refugees through iris scanning. Democracy Notary: Protects the integrity of important government or civil society documents.
	Supply chain traceability can contribute to achieving Target 8.7, as it can prevent forced and child labor.	The Other Bar: applies traceability to the fair-trade chocolate supply chain.		Encouraging official development assistance through more transparent donations.	Disberse: tracking of funds throughout the entire financing chain, from donor to beneficiary.

ISSN: 0012-7361 eISSN: 1989-1490 / DYNA Vol.XX nºX DOI: https://doi.org/10.6036/XXXX

	Increasing access to financial services for small industries, particularly in developing countries (Target 9.3).	AgriDigital Waypath: supply chain finance for grain and cotton farmers and buyers.			

Table 2: Positive impacts of the Blockchain on the 17 SDGs

Annex II (see supplementary material on Dyna's website) describes in more detail the positive impact of the Blockchain on each SDG, and example cases.

3.2. NEGATIVE IMPACTS OF THE BLOCKCHAIN TO THE SDGS

The Blockchain is a relatively immature technology and at the moment its widespread implementation could generate problems that jeopardize sustainable development. For example, today cryptocurrencies consume a lot of energy, which is harmful to the planet and accelerates the consequences of climate change. On the other hand, their complexity, and the need to have technological elements for their implementation and development could increase inequality between people and countries, as only a few could benefit from and use this technology. In addition, BC has several barriers to its implementation, so that example cases that benefit the SDGs could be hindered, delaying their implementation, or failing in the future.

Table 3 summarizes the negative impacts that CB could have on the different SDGs

Disadvantage	What does it cause?	SDGs affected
High energy use	Energy footprint and Co2 emissions	SDG 7, SDG 12, SDG 13
High storage requirements	Need for increased computational capacity	SDG 9
Lack of regulation	Criminal activities and speculation associated with cryptocurrencies	SDG 16
Lack of education	Complexity causes inequality	SDG 1, SDG 4, SDG 10
Lack of access to technological resources	Cost of access causes inequality	SDG 1, SDG 10

Table 3: Negative impacts of Blockchain on SDGs

Each of the different disadvantages is described in more detail below.

Technical problems: high energy and storage requirements

One of the main problems BC presents for the achievement of the SDGs is the high energy footprint of this technology, especially in the case of bitcoin as it is designed to foster a large computational effort in its mining processes. In fact, the Cambridge University Centre for Alternative Finance (CCAF) estimates that bitcoin consumes approximately 130 terawatts per hour, a very high cost compared to other cryptocurrencies and traditional banking transactions, more than some countries such as Denmark or Ireland [11]. Also, the study [12] indicated that cryptocurrency mining consumed more energy than mineral mining to produce an equivalent market value. This consumption generates CO2 emissions that pose a threat to the environment, and therefore poses a threat to the SDGs, especially 13 (Climate Action), 7 (Affordable and Clean Energy) and 12 (Responsible Production and Consumption). However, various CB developers are increasingly moving towards schemes that are energy efficient [13].

On the other hand, Blockchains require records that would have to be stored in each of the nodes. In this way, the ledgers could grow very large over time. If these grow excessively, they could become non-functional for users (nodes) since they would weigh too much to be downloaded and stored [14]. Therefore, with the increase of BC the cost of data storage on the Internet would increase, which is directly related to SDG 9 (Industry, innovation, and infrastructure). If BC encourages lack of access to this platform and makes it less sustainable it would be hugely detrimental. The solution that has been presented to the data storage problem is the creation of "sidechains" that store data but do not increase the weight of the central BC [13].

ISSN: 0012-7361 eISSN: 1989-1490 / DYNA Vol.XX nºX DOI: https://doi.org/10.6036/XXXX

Lack of regulation

Blockchain, as a technology, is still maturing. There are no standards or best practices, and its legal recognition is limited [8].

In the case of cryptocurrencies, they may have a special attraction for criminals due to their semi-anonymity and decentralization characteristics that offer opportunities for money laundering, illegal fundraising [15] and new forms of fraud and theft [16]. Therefore, many countries are urgently introducing regulation. Policies range from total prohibition, as in the case of Namibia, to total acceptance, as in Estonia.

On the other hand, with the rise and widespread adoption of this technology, the frequency of data breaches could increase, especially in public Blockchains that contain private information of individuals and can lead to significant business risks. A clear example would be the hack of the Bitcoin exchange MtGox in 2014, when hackers were able to steal $450 million in Bitcoin and were not identified [15].

Finally, it should be noted that cryptocurrencies are not a safe asset for personal savings because they can be accidentally deleted and/or hacked in addition to having high volatility, which fuels speculation that can disrupt the global financial system being especially detrimental to the most vulnerable people [16].

The Blockchain needs a worldwide legal and regulatory environment for Blockchains to be operable, as each node may be located in a different part of the world. This means that it will be unclear to which jurisdiction a Blockchain will belong. Therefore, mechanisms must be established to resolve legal conflicts by deciding which laws will apply and which courts have the right to decide on certain issues [17].

According to [18], in order to regulate this technology, a unified and multilateral approach should be introduced. To this end, all people should be included in the management and codification of this tool since its implementation will have impacts at different scales. In addition, regulations should also include fiscal tools that incorporate the externalities generated by each BC in their design to motivate the change of this sector towards models that use less energy, for example.

Lack of education and technological barriers

The opportunities offered by the Blockchain may only be fully enjoyed by a few due to the cost of access and complexity of this technology, thus increasing inequality between people and countries (SDG 10).

Consequently, technology education is critical to achieving a digital transition and making disruptive computing technologies more inclusive. Everyone needs to be taught how to manage data highways and understand the principles of cryptography and key management. Various research has shown that only one third of the population can understand data and statistics, and Blockchain goes much further, requiring citizens to embrace a completely new approach to data management [18]. In addition, the lack of clarity about how the technology works will make it more difficult to implement, and therefore more complicated to be used in cases that will benefit the achievement of the 2030 Agenda.

Likewise, if BC is not to foster inequality, the digital divide suffered by the most marginalized people must be reduced: the poor, the displaced, and rural populations, who are the least likely to have access to reliable Internet connections [19].

Security issues

Access to most Blockchains requires both a public and a private key. Therefore, accessing the data on the chain requires both keys. This poses a cybersecurity problem, as the protection of these keys depends on the user person storing and processing them securely, which can be daunting for people unfamiliar with the technology and an opportunity for hackers [17].

In addition, Blockchain ecosystems rely heavily on coding new algorithms, a procedure that can be error-prone but will be solved as the technology matures [13].

A comparative table showing the positive and negative impacts of BC use on the SDGs is shown in Annex III (see supplementary material on Dyna's website).

The appropriate set of parameters and ranges for the correct identification of building typologies will depend to a large extent on the history and location of the historic district. Informed judgement will therefore be required to determine which parameters play a key role in the clustering process. This process can be aided by various statistical methods and tools that serve to represent the distribution of the various parameters in the framework of the building stock analysis. In the literature, e.g., in [11], reference is made to the use of frequency histograms for the identification of concentrations of specific values. The boxplot is used to graphically represent groups of numerical data by means of quartiles. A histogram combined with a boxplot helps to clearly understand the normality, trend and dispersion of the data [12].

4. CONCLUSIONS

ISSN: 0012-7361 eISSN: 1989-1490 / DYNA Vol.XX nºX DOI: https://doi.org/10.6036/XXXX

Blockchain is a technology whose characteristics enable it to offer solutions to current and future challenges associated with sustainability. These characteristics are that it offers security, transparency, favors traceability, and allows the reduction of transaction costs and the time in which these are carried out. In addition, it is worth highlighting its wide applicability since it offers solutions to different problems and opportunities faced by today's society in each of the objectives of sustainable development. Therefore, Blockchain technology will have a strong impact on society, as well as on the industry related to sustainability, generating new business opportunities and green jobs.

However, Blockchain technology also has a number of disadvantages in relation to sustainability which can be summarized in that it has a high energy consumption, it is still an immature technology, its size is constantly growing which would produce storage problems, its security depends on codes that can be forgotten, there is a lack of education in technology, there are barriers to access to technology for some people, there is a lack of regulation and agreements around BC, and its boom is linked to speculative markets.

Therefore, it can be concluded that BC can generate opportunities to achieve the SDGs, but these advances must consider sustainability criteria to avoid further environmental degradation and increased inequalities. In this sense, when designing new applications and systems, potential negative impacts and barriers to their adoption must be considered. There is also a need for a change in culture, awareness, and business support for this new technology. At the same time, strategies and policies must be defined to integrate Blockchain technology into existing operational and management environments.

The results of this study are useful for engineers, as it identifies the technological aspects of BC that need to be improved, such as the design of less energy-intensive mining processes or the combination of BC with other disruptive information technologies such as Big Data, the Internet of Things(IoT) or Artificial Intelligence; for business managers, as they can appreciate the positive impact that this new technology could have on sustainability if it is applied correctly; and for politicians, as it poses a series of challenges, such as establishing mechanisms to facilitate access to BC technology, creating networking infrastructures or promoting technological education for all people, as well as the need to carry out reforms, such as establishing mechanisms to facilitate access to BC technology, creating networking infrastructures or promoting technological education for all people; and for politicians, for whom it poses a series of challenges such as establishing mechanisms to facilitate access to BC technology, creating network connection infrastructures or promoting technological education for all people, as well as the need to carry out regulatory reforms, such as establishing international agreements that jointly regulate which measures and regulations will be applied to Blockchains, which are in turn international since each node can be established in a different country.

In conclusion, the use of Blockchain is going to spread and it is the responsibility of all people: managers, engineers, regulators, educators, workers, etc. to apply criteria of sustainability and ethics so that its development generates good practices that promote sustainable development and the achievement of the 2030 Agenda.

REFERENCES

[1] Medaglia, R. and Damsgaard, J. (2020). Blockchain and the United Nations Sustainable Development Goals: Towards an Agenda for IS Research. PACIS 2020 Proceedings, 36. Retrieved from: https://aisel.aisnet.org/pacis2020/36 consultado el 30/11/2021

[2] Benavent-De Barbera, M., Carrascosa-Cobos, C., Santamaria-Gonzalez, V. (2022). Concrete Blockchain Applications And Legal Aspects. *DYNA*, 97(1). 7-8. DOI: https://doi.org/10.6036/10227

[3] Santamaria-Gonzalez, V., Benavent-De Barbera, M., Carrascosa-Cobos, C., Herencia-Anton, J. (2021). Evolution And Future Of Blockchain: From Cryptocurrencies To Industrial Applications. *DYNA*, 96(6). 559-560. DOI: https://doi.org/10.6036/10226

[4] Adams, R., Kewell, B. and Parry, G (2018). Blockchain for good? Digital Ledger Technology and Sustainable Development Goals. Springer International Publishing, DOI: 10.1007/978-3-319-67122-2_7.

[5] Maesa, D., and Mori, P. (2020). Blockchain 3.0 applications survey. *Journal of Parallel and Distributed Computing*, 138, 99–114. DOI: 0743-7315

[6] Lecuit, J. A. (2019). La seguridad y la privacidad del Blockchain, más allá de la tecnología y las criptomonedas. Real Instituto Elcano, 49.

[7] Conde, A. (2019). La Blockchain, ¿revolución o burbuja?. El Orden Mundial. Recuperado de: https://elordenmundial.com/la-Blockchain-revolucion-o-burbuja/ Consulted: 15/10/21.

[8] Deloitte, (2017). Blockchain: Economía de confianza. Tomando el control de la identidad digital. University Press, 93-105.

[9] Crosby, M., Pattanayak, P., Verma, S., and Kalyanaraman, V. (2016). Blockchain technology: Beyond bitcoin. *Applied Innovation*, 2(6-10), 71.

[10] [Muguerza, M., y Chalmeta, R. (2020). Educación para el desarrollo sostenible: análisis del Centro de Secundaria Iturrama. RIDE *Revista Iberoamericana para la investigación y el desarrollo educativo*, 11(21). DOI: https://doi.org/10.23913/ride.v11i21.766

ISSN: 0012-7361 eISSN: 1989-1490 / DYNA Vol.XX nºX DOI: https://doi.org/10.6036/XXXX

[11] Rowlatt, J. (2021). Cómo el descomunal gasto de energía del bitcoin puede hacer explotar la "burbuja" de las criptomonedas. Retrieved from: https://www.bbc.com/mundo/noticias-56144398 Consulted: 17/11/21

[12] Krause, M. J. and Tolaymat, T. (2018). Quantification of energy and carbon costs for mining cryptocurrencies. *Nature Sustainability*, 1, pp.711–718. DOI: https://doi.org/10.1038/s41893-018-0152-7

[13] Andoni, M., Robu, V., Flynn, D., Abram, S., Geach, D., Jenkins, D., McCallum, P., Peacock, A., (2018). Blockchain technology in the energy sector: A systematic review of challenges and opportunities. *Renewable and Sustainable Energy Reviews*, 100, 143-174, DOI: https://doi.org/10.1016/j.rser.2018.10.014.

[14] Zhou, J., Yunna, W., Fangtong, L., Yao, T., Jianwei, G. (2021). Prospects and obstacles analysis of applying Blockchain technology to power trading using a deeply improved model based on the DEMATEL approach. *Sustainable Cities and Society*, 70, ISSN: 2210-6707, DOI: https://doi.org/10.1016/j.scs.2021.102910.

[15] UNCTAD, (2021). Issues Paper on Harnessing Blockchain for sustainable development: prospects and challenges. Retrieved from: https://unctad.org/system/files/information-document/CSTD2020-2021_Issues02_Blockchain_en.pdf Consulted: 10/11/21.

[16] Dierksmeier, C. and Seele, P. (2018): "Cryptocurrencies and Business Ethics" *Journal of Business Ethics*, 152, nº 1, pp. 1- 14.

[17] World Economic Forum [WEF], (2018). Building Block(chain)s for a Better Planet. Fourth Industrial Revolution for the Earth Series. Retrieved from:: https://www.weforum.org/reports/building-block-chain-for-a-better-planet consultado el 26/09/21.

[18] Mulligan, C. (2019). Blockchain and Sustainable Growth. Recuperado de: https://www.un.org/en/un-chronicle/Blockchain-and-sustainable-growth Consulted: 15/04/21.

[19] Programa de las Naciones Unidas para el desarrollo [UNDP], (2019): Más allá del bitcoin. Retrieved from: https://feature.undp.org/beyond-bitcoin/es/ Consulted: 10/07/2021

ISSN: 0012-7361 eISSN: 1989-1490 / DYNA Vol.XX nºX DOI: https://doi.org/10.6036/XXXX

SUPPLEMENTARY MATERIAL

ANNEX I

I.1 HOW DOES THE BLOCKCHAIN WORK?

Blockchain is a chain of blocks of digital information, essentially working as a ledger of distributed accounts; transparent, constantly updated with every transaction and irreversible.

The technology works this way: every time someone wants to make a transaction it is added to the Blockchain platform and the transactions are arranged in chronological order in groups called blocks, the transactions in a block are considered to have occurred at the same time. Transactions record various digital assets such as who owns what, who carries out which transactions, what is exchanged and when. These blocks are then linked together chronologically and cryptographically through algorithms, forming the Blockchain.

Transactions are not recorded in a single database, but are distributed among the computers in the system's network of users - nodes - which form a peer-to-peer network. All nodes have the same version of the log and this is achieved through consensus - nodes must agree to update or add a new transaction to the system - hence nodes not only store copies of the distributed log but also verify the log.

The process involves actors that can adopt three roles: users with the right to have and consult a copy of the distributed database - accessors-, participants with the right to carry out transactions -participants- and users in charge of validating transactions and creating blocks -miners-.

The Blockchain uses cryptographic security mechanisms to access, sign and encrypt transactions, blocks and their chaining. Miners function as nodes for this technology; in order to verify transactions, they provide the necessary computational power with their computers. In this way, the nodes use algorithms to convert the information in a block into an alphanumeric code (hash) that is linked to the hash of the previous block, thus creating the block chain. Specifically, blocks of digital property are transferred along the chain, miners verify the veracity of the blocks, and nodes verify the work of the miners.

The main role of the miners is to ensure the irreversibility of new transactions, making them final and tamper-proof. The method they use to do this is proof of work. Any miner attempting to add a new block must also provide an accompanying cryptographic proof. To produce the proof, the miner digests the new block through multiple rounds of a hash function, a calculation that takes a piece of data of arbitrary length and reduces it to a meaningless alphanumeric string with a fixed length, called a "hash".

These proofs of work are costly in terms of computing power and therefore electricity. Miners are therefore paid for each block they add to the chain, which once added is immutable. Each BC platform determines how miners participate (speed, computational cost, energy, etc.) and how miners are rewarded, which can be in cryptocurrencies, shares in the business, etc.

In conclusion, Blockchain implements a distributed ledger by grouping records into blocks that are made tamper-resistant by adding a cryptographic signature to the block data. The blocks are then chained together, linking each block to its predecessor, so that they cannot be tampered with. The most common way to achieve this is by cryptographic hash functions, adding the hash of the previous block to the next block header. In this way, each block depends on both its content and the previous block in the chain, i.e. each block depends on the content of all the previous blocks, until it reaches the first block created.

I.2 FEATURES OF BLOCKCHAIN

There are three properties that are generally attributable to Blockchain networks and can be seen in Figure 1. However, each BC network may have other characteristics depending on its functionality.

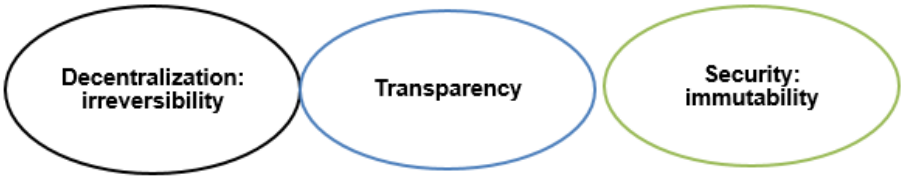

Figure 1. Features of the Blockchain

Decentralization

The system used by Blockchains to store data in the network is distributed, which makes this technology irreversible. In other words, no authority owns the information, since it is distributed in different blocks, thus reducing the risk of a master copy being lost due to hacker attacks or natural disasters. Likewise, when information is incorporated into a BC network it is not possible to eliminate it, since

ISSN: 0012-7361 eISSN: 1989-1490 / DYNA Vol.XX nºX DOI: https://doi.org/10.6036/XXXX

the information is distributed and owned by all the nodes that belong to the network, therefore, all the nodes should be attacked simultaneously to eliminate certain information.

Consequently, the BC is an independent data registry and one of the most secure data transport systems available today. It can thus provide users with control over their digital identities and universal availability, without the need to operate through intermediary organizations or institutions.

Transparency

All users of Blockchain networks have access to the ledger, which is shared through a decentralized network. Therefore, everyone has the information about the transactions that take place and even sometimes, as in Bitcoin and Ethereum, users who are not part of the network.

However, the fact that transactions are public does not mean that their authors are public. In fact, in some networks it is not necessary to identify oneself to operate through the Blockchain network, i.e. transactions are visible, but they are linked to a code and not to a user.

Security

Blockchains are virtually unalterable since each transaction is authenticated by recording the date, names of participants, and the type of information required, and as a consequence of the successive chaining between blocks based on cryptography, no changes can be made to any block since this would alter the entire database.

Likewise, for a transaction to take place there must be consensus among the signing parties. If a node unilaterally decides to change the content of the Blockchain by altering a transaction it would cause the content of its version of the ledger to vary, therefore, the rest of the nodes would identify this change and would not accept this version of the record.

I.3 TYPES OF BLOCKCHAIN PLATFORMS

Each Blockchain platform establishes its rules of participation, operation and governance. Platforms can be open -public- if they are accessible without restrictions to any user with internet access. Public Blockchains are self-managed, participants can access the database, store a copy and add information becoming a node or miner thus approving new blocks. In this way, blocks are created that cannot be modified in accordance with the principle of irreversibility. A clear example is the Bitcoin and Ethereum cryptocurrencies.

They can also be private when a central actor or authority sets the rules. These networks are not open to the public and must be accessed by invitation, only certain people authorized by the administrator have access to the database, either to read or to write. Thus, it offers transparency, privacy and control within the group for a defined set of users. In this case, the difference between a Blockchain and a conventional decentralized database is blurred. Examples are Hyperledger or Ripple.

Finally, they can be semi-public or authorized when participation, the right to veto new members or the possibility of deciding the consensus protocol at the beginning of the chain is conditioned. Through these networks, any user can have a copy of the database and transactions can be visible, but only authorized persons can modify and create blocks.

The purest form of Blockchain is permissionless-public-as it is highly resistant to censorship and can provide an immutable global record, validated by the network. Consequently, some authors argue that private and semi-public BCs are not Blockchains but business tools for process improvement and optimization and profitability.

ISSN: 0012-7361 eISSN: 1989-1490 / DYNA Vol.XX nºX DOI: https://doi.org/10.6036/XXXX

ANNEX II

SDG 1: Ending poverty through microfinance

According to the World Bank, 1.7 billion adults worldwide are unbanked or operate outside the banking system altogether, yet two-thirds of unbanked adults have access to a cell phone. Target 1.4 of the SDGs aims to ensure the right to a variety of economic resources for everyone in the world, making it easier for the poorest people in particular to access microfinance.

Blockchain technology can process microtransactions in a simple way and thus reach more people than in the traditional financial system, which does not find it profitable to offer financial services below a certain threshold. This technology facilitates microfinance by making the financial industry more accessible, faster, cheaper and easier.

In Tajikistan there is a UNDP pilot project between AltFinLab and the BitSpark company that helps migrant workers transfer money through a mobile application running in BC. This allows for tracking transfers of funds along the entire funding chain from donor to beneficiary in a cheaper, faster and more direct way, avoiding the additional expense of a trip to the nearest city to pick up money or the risk of the store or money transfer location running out of cash. Users can open an account by simply entering a phone number and digitally verifying their identity. Transactions are done instantly and at a fraction of the fees charged by traditional intermediaries.

SDG 2: End hunger through the protection of smallholders

According to UN data, one in nine people in the world is currently undernourished. To end hunger, the UN proposes investing in smallholder farmers as a way to increase food security and nutrition for the poorest, as well as food production for local and global markets. This is reflected in target 2.3 of the SDGs.

Climate change is modifying weather patterns around the world - rainfall, rainfall, winds, etc. - and smallholder farmers are especially vulnerable to these phenomena. - and smallholder farmers are especially vulnerable to these phenomena. Traditional insurance companies do not provide adequate coverage for farmers, let alone smallholder farmers in developing countries, who therefore live in very unstable situations due to bad weather conditions that can destroy their financial well-being. Fortunately, smart contracts can take into account these changing weather conditions through oracles[1] , which can offer a solution or at least a way for people with little means to hedge against a major risk.

Insurance projects such as Arbol and Etherisc offer farmers around the world crop insurance based on smart contracts. In this way, farmers can take out a policy by setting predefined conditions for contract performance-such as a certain amount of rainfall-and then rely on oracles to monitor weather patterns. If the oracle network reports that a certain metric has been met, the farmer automatically receives a payout. Thus, farmers can protect their financial future by simply needing a smartphone.

SDG 3: Health and wellness through a single health record

BC is an enabling technology for the implementation of a single medical record that is owned by each person, i.e. it allows each person to give permissions to institutions in different countries to have access to their medical history. This measure could contribute in a cross-cutting manner to all SDG 3 targets as it could show relevant information such as allergies, vaccination guidelines, etc. of each person so that they can be attended correctly and efficiently in all countries of the world.

In addition, BC facilitates records management and streamlines communication, outbreak tracking, medical supply chain tracking or disease prevention when complemented with other Industry 4.0 tools.

Patientory is a platform for storing, managing and transferring private health information by executing smart contracts on the Ethereum Blockchain.

SDG 4: Quality education through decentralized registries

Blockchains can be used to store records, secure student identities and credentials, transfer credits, process payments and student scholarships, and protect and even track intellectual property use of educational content. This would reduce management costs and fraud by omitting manual verification of degrees and transcripts, while increasing efficiency through automated smart contracts. Ultimately, BC would favor access to scholarships directly impacting target 4.b and improve educational facilities, positively impacting target 4.a.

ODEM is a BC-powered education platform that provides a decentralized educational registry in which students, educators, and schools operate autonomously while enjoying full control over their educational data. This supports integrated enrollment, learning management, and the issuance of Blockchain-backed digital certificates, which can be used to track progress and achievement.

SDG 5: Achieve gender equality

[1] Oracle Blockchain: This is a third-party service that provides external information for smart contracts to make decisions. In this way, decentralized knowledge is obtained.

ISSN: 0012-7361 eISSN: 1989-1490 / DYNA Vol.XX nºX DOI: https://doi.org/10.6036/XXXX

Women in developing countries are more likely to earn their income in the informal sector, suffer from financial illiteracy, have limited mobility and even lack identification. UN Women is exploring Blockchain-based solutions to support humanitarian response targeting women and girls in emergency situations, such as refugees, to secure their identity, medical and asset ownership records.

These measures favor the fulfillment of SDG 5.a and 5.b, given that technology is used to empower women and favors their right to control economic and financial resources.

SPENN is a digital wallet that allows users to interact with each other using their smartphones to receive, save, transfer and spend money. Consequently, in refugee camps it eliminates the need for women to carry physical cash and gives them greater control over their financial resources. The Norwegian VipiCash app has also been developed to transfer money securely and reduce remittance costs. It allows women in refugee camps to decide how they will spend the money, independently of the men in their families, as the money can be blocked for a specific use, for example, to buy food or pay school fees.

SDG 6: Ensure availability of water and its sustainable management

One of the major problems we face is water scarcity, which affects more than 40% of the world's population and is expected to increase in the coming decades. To promote efficiency in the use of water, oracles are established that favor the remote communication of information through enabling technologies such as sensors, meters and automated controls, which continuously monitor the water distribution system. Some of the parameters they account for are pressure, quality, flow rates, temperature and leakage. Thanks to BC, access to this information could be democratized and data manipulation could be avoided, thus mitigating the tensions experienced by certain regions when solving a conflict-causing cause.

The Kilimo irrigation management platform analyzes satellite, climate and field data to determine an automatic balance and measure the water footprint of each agricultural project in different countries. In this way, it promotes water savings. To provide fast and secure irrigation recommendations, the platform is based on Big Data and has also started issuing smart certificates protected with Blockchain technology.

SDG 7: Sustainable and affordable energy

Energy is the main contributor to climate change, accounting for around 60% of all global greenhouse gas emissions. The Blockchain can incentivize the use of renewable energy and more sustainable energy use (target 7.2), favoring decarbonization through optimized distributed grid management and authentication of renewable energy. For example, CB could provide security to the information provided on energy and thus help control its use, since it could collect details on the source, destination, amount of energy transferred, associated losses or ancillary services employed.

Likewise, the Blockchain can help offset surplus self-consumption of solar energy through peer-to-peer renewable energy exchange systems, thus favoring access to electricity for thousands of people still living without it (goal 7.1).

The Sun Exchange is an online marketplace that finances solar energy with cryptocurrency. Owners of solar cells can lease them to hospitals, businesses, schools and private residences, and then receive SolarCoins (solar coins) based on the amount of solar energy produced. This allows rural communities to produce their own energy sources, keep the profits and even provide backup power to the grid.

SDG 8: Promote inclusive and sustainable economic growth, employment and decent work for all through supply chain traceability.

Supply chain processes are often complex and opaque, especially when they are global and depend on different countries with different regulations, which makes it difficult for companies to implement commitments as they are in the hands of different actors that are not always under their control. The data generated along the supply chain, from the origin of the product to the point of sale, can be recorded through the Blockchain, storing the information generated immutably.

Efficient and transparent chain management should be a priority for everyone. By offering tracking and traceability of all processes and product lifecycle, with security and low transaction costs, Blockchain technology can change the way in which due diligence of each product is verified, contributing to the final consumer or retailer's decision making.

Therefore, traceability of supply chains can positively impact all SDGs, but especially it is a tool to meet target 8.7 and eradicate forced labor, end slavery and child labor in all its forms.

In Ecuador, BC technology is being used to contribute to fair trade. UNDP, AltFinLab and the Amsterdam-based FairChain Foundation are developing "The Other Bar," the first traceable shared-value chocolate with Blockchain. Consumers can track every ingredient found in a chocolate bar and ensure that it has been sourced fairly and sustainably. In this way, the price will reflect the impact on the ecosystem and the actual costs of production and export, and farmers will receive a significantly higher share than through other methods.

On the other hand, car companies Volvo and BMW are using this technology to track the raw materials used to manufacture lithium batteries for their electric cars. In fact, cobalt is a key element that is affected by child labor and other human rights abuses.

ISSN: 0012-7361 eISSN: 1989-1490 / DYNA Vol.XX nºX DOI: https://doi.org/10.6036/XXXX

SDG 9: Build resilient infrastructure, promote sustainable industrialization and foster innovation.

BC can have a positive impact on target 9.3 by increasing the access of small industries and other businesses, particularly in developing countries, to financial services, including affordable credit, and their integration into value chains and markets.

AgriDigital Waypath is a commodity management platform that provides transactional trading and inventory management capabilities to farmers, elevators and traders in the grain sector, as well as access to supply chain finance for farmers and buyers of grain and cotton. By digitizing, connecting and securing farmers' supply chains, it enables all participants in the supply chain to operate more efficiently and access financing.

SDG 10: Reduce inequality within and between countries

Economic inequality is of particular concern because it causes the most vulnerable people to suffer the consequences of the various crises affecting the world. For example, the COVID-19 pandemic has shown that social, political and economic inequalities have amplified the effects of this crisis.

Applications based on BC technology are being developed that process micro loans, which is vital to favor the economic inclusion of the underprivileged. Likewise, Blockchain solutions have been developed to impact target 10.c and reduce the transaction costs of migrant remittances.

SDG 11: Making cities more inclusive, safe, resilient and sustainable

In order to achieve SDG 11, BC technology can be applied to address issues such as waste management, urban planning, green energy, public transportation, traffic management and security among others. The UN has set up a working group called Blockchain4cities to determine what applications BC can have in the operation of smart cities.

For two-way communication between the local government and the inhabitants of the city of Moscow, an active citizen system has been developed to collect the opinions of all citizens through online BC-based referendums. To encourage participation, the system awards points that can be exchanged for souvenirs or tickets to theaters or museums.

In Malta, the government is developing an efficient and sustainable public transport platform. They are applying BC-based systems to predict growth, balance routes and optimize services based on passenger behavior using GPS systems and trip tracking.

Ant financial's initiative: HK-Philippines Cross-Border Remittance Project improves the speed, efficiency, security and transparency of cross-border remittances between Hong Kong and the Philippines.

SDG 12: Responsible production and consumption

To incentivize more sustainable consumption decisions, smart contracts can be used so that consumers automatically receive payments or penalties based on the impact of their consumption habits.

On the other hand, the collaborative economy has been heralded as a solution to sustainability challenges by promoting environmentally friendly forms of consumption, encouraging different ownership models and addressing issues such as underutilization of assets. "The Blockchain offers an opportunity to give authenticity to what is meant by collaborative with respect to the proposals that exist today" (because its properties allow the value of the ecosystem to be distributed among participants, therefore, it can correct some of the problems associated with this type of Economy, such as the exploitation of false freelancers by some delivery or mobility services applications.

To promote sustainable tourism, the NetObjex project has been developed based on installing IoT devices in selected hotels to track guests' water and energy consumption during their visit. Using oracles the smart contracts can interact with each guest's data and automatically calculate and reward guests based on their consumption metrics.

On the other hand, La'Zooz is a decentralized transportation platform, owned by the community as a whole, and utilizing the unused space of vehicles, allowing people with private cars to share their ride with others traveling the same route: a decentralized Uber. La'Zooz generates new tokens from "Proof of Motion," not "Proof of Work." While driving, drivers earn Zooz, passengers pay with Zooz and can also earn Zooz by providing route tips to drivers. Thus, La'Zooz offers a ride-sharing transportation service that is based on the principles of the collaborative economy, rather than monetary incentives. The business model shifts from rent extraction to value creation that is distributed among those who created it.

SDG 13: Take urgent action to combat climate change

Levels of carbon dioxide (CO2) and other greenhouse gases in the atmosphere are steadily rising, so action must be taken to address the climate emergency to save lives and livelihoods.

BC technology can significantly improve transparency, accountability and traceability of greenhouse gas emissions. It helps companies provide more accurate, reliable, standardized and readily available carbon emissions data. Through smart contracts and BC, carbon reduction in the supply chain of companies-including manufacturers, suppliers, distributors and consumers-can be calculated, tracked and reported through the verification and recording of reliable data.

ISSN: 0012-7361 eISSN: 1989-1490 / DYNA Vol.XX nºX DOI: https://doi.org/10.6036/XXXX

On the other hand, in markets where carbon emission rights are traded, companies can exceed the limits indicated by their certificates by acquiring rights from other entities. Through the Blockchain, a system could be designed to avoid the falsification of certificates and their double accounting. In this way, existing information would be tracked and immutably recorded since each record would be unique, and could only be transferred through the digital signature of the authorized person. Likewise, by means of BC platforms, these markets could be optimized through cryptographic tokens that allow the creation of negotiable securities and favor their transactions.

Also, as the frequency and scale of natural disasters increase, in part due to climate change, there is a need to prepare for and proliferate resilience. BC solutions could be transformative in terms of natural disaster warning and real-time monitoring of natural hazards.

Everledger, through Blockchain technology and other tools such as artificial intelligence, allows the diamond industry to measure in real time the data related to the carbon footprint of its own manufacturing processes and even that of the entire value chain, in this way companies can offset the carbon footprint it generates, mitigating or neutralizing carbon emissions.

SDG 14: Conserve and sustainably use the oceans, seas and marine resources

More than three billion people depend on marine and coastal biodiversity for their livelihoods, and the ocean drives the global systems that make the Earth habitable for humans. BC technology can be used to control and monitor ocean conditions - such as temperature and pH - in real time and provide transparency of data on marine pollution levels.

It can also be used to curb illegal fishing (target 14.4) by sustainably managing marine and coastal ecosystems and the fish market. By limiting illegal, unreported and unregulated fishing, the oceans, seas and marine resources would be conserved and used more sustainably.

Pacifical MSC Sustainable Tuna is an initiative that promotes sustainable tuna fishing in Oceania - where 25% of the world's tuna stocks are found - through certificates that verify the sustainable supply chain.

SDG 15: Sustainably manage forests, combat desertification, halt and reverse land degradation, and halt biodiversity loss.

BC could also help to halt deforestation processes (target 15.2), as it would provide security of property rights, preventing the appropriation and exploitation of resources in protected areas that lead to the extinction of species, loss of biodiversity, soil degradation, etc.

UNDP is running a crowdfunding platform called Live Lebanon that focuses on raising awareness and funds from citizens to help with reforestation. Arguably, this is an impact investing initiative as for each new tree planted CedarCoins are distributed to investors and to the local communities that host the trees, promoting reforestation efforts and rewarding environmentally conscious behavior. In the future, coin holders will be allowed to choose the tree, its location and obtain its GPS coordinates. This provides security for investors who can verify where their money is actually being spent.

SDG 16: Peace, justice and strong institutions

More than one billion people do not possess legal identification, most of them refugees or migrants in transit. This can restrict their access to various rights and opportunities as they are unable to formally participate in democratic, educational, health and economic activity. The Blockchain can have an impact on target 16.9 of the SDGs which aims to provide a legal identity for all without the need for it to depend on a central authority and being controlled by them, deciding which attributes can or cannot be made public depending on authentication needs.

A digital identity, based on BC and accessed through mobile devices and/or combined with biometrics - such as iris scanning - can offer a solution to people without an identity. In addition, this type of digital identity can be more secure against identity theft and improve data privacy.

In 2017, the World Food Program tested a BC platform to enable Syrian refugees in Jordan to pay for food using an iris scanner instead of cash or electronic vouchers. Once authenticated, data is recorded via Blockchain, allowing beneficiaries to establish their identities without sharing unnecessary personal data.

SDG 17: Partnerships to achieve the goals

Many countries require official development assistance to promote growth and trade, which is why SDG 17 seeks to adopt and implement investment promotion schemes in favor of the least developed countries.

By providing transparency and accountability without the need for costly intermediaries, Blockchain offers opportunities to increase funding and explore new sources of financing, such as philanthropy. At the same time, cryptocurrencies can be used to channel funds to specific causes or communities.

Specifically, the BC allows the almost instantaneous transfer of digital tokens, and if not at zero cost, then at an amount significantly cheaper than traditional services. This makes the transfer of small amounts of money economically viable, allowing the entry of new

ISSN: 0012-7361 eISSN: 1989-1490 / DYNA Vol.XX nºX DOI: https://doi.org/10.6036/XXXX

players in the field of microfinance and new opportunities for e-commerce, thus favoring the financial inclusion of all people.

The Disberse platform allows funds to be tracked throughout the entire financing chain, from donor to beneficiary. It also offers the option to make payments dependent on the achievement of goals. These advantages will help assure donors that their money is well invested and encourage donations and investment in social and environmental causes.

ISSN: 0012-7361 eISSN: 1989-1490 / DYNA Vol.XX nºX DOI: https://doi.org/10.6036/XXXX

ANNEX III

Positive Impacts	Negative Impacts
It facilitates microfinance by making the financial industry more accessible, faster, cheaper and easier.	High energy use
Smallholder farmers in developing countries can obtain insurance coverage not covered by traditional insurance companies thanks to CB smart contracts	High storage requirements
Allows to obtain a personal medical record owned by each person, accessible from anywhere in the world.	Lack of regulation
Facilitates the management of educational administrative processes	Lack of education
It empowers women and gives them the right to control their economic and financial resources.	Lack of access to technological resources
Promotes water use efficiency by democratizing access to information provided by water distribution systems.	
It favors the use of renewable energy and a more sustainable use of it, as well as helps to offset the surplus of self-consumption of solar energy.	
Enables traceability and immutability of all the data generated throughout the supply chain.	
Increases access to financial services, including affordable credit, for small industries and other businesses.	
Enables the development of software applications to make cities more inclusive, safe, resilient and sustainable.	
It incentivizes sustainable consumption decisions through smart contracts that automatically make consumers receive payments or penalties based on the impact of their consumption habits.	
Enables significantly improved transparency, accountability and traceability of greenhouse gas emissions	
It allows real-time monitoring and control of ocean conditions and provides transparency of data on marine pollution levels.	
It provides security to the property rights of protected areas, preventing their appropriation and exploitation of their resources, which leads to the extinction of species, loss of biodiversity, soil degradation, etc.	
Allows to provide a legal identity to individuals without the need for a central authority	
Enables the promotion of investments in favor of the least developed countries	

Comparative table of positive and negative impacts of BC use on the SDGs

ISSN: 0012-7361 eISSN: 1989-1490 / DYNA Vol.XX nºX DOI: https://doi.org/10.6036/XXXX