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THE IMPACT OF BLOCKCHAIN TECHNOLOGY IN THE LIGHT OF SUSTAINABLE FINANCE AND SDGS: A LITERATURE REVIEW

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1 Introduction

The surge in trade volumes over recent decades has led to supply chains evolving into intricate and interconnected networks, encompassing suppliers, manufacturers, carriers, wholesalers, retailers, banks, and trade organisations worldwide. Such complexity has raised concerns ranging from disruptions, delays, inefficiencies and fraud to social issues such as poor working conditions and child labour. In this context, the main features of blockchain technology - data integrity and security, platform governance, transparency, database maintenance, and smart contracts - have emerged as a solution to ensure secure and reliable chains with end-to-end visibility (Chen, Botchie, Braganza & Han, 2022).

While blockchain is an emerging technology, its broad-scale adoption is not widespread, as underscored by Mosteanu and Faccia (2020), who describe it as the chronological ledger of block transactions encrypted based on a chain of digital signatures. This technology has significant positive impacts on the growth and efficiency of partnerships and is regarded as an information technology tool for sustainable supply chain management (Kim & Shin, 2019; Zhao et al., 2019).

Existing literature demonstrates the benefits of its use from various perspectives: its potential to accelerate the Fourth Industrial Revolution, change the economy in the immediate future, and achieve a more sustainable world (Parmentola et al., 2022). Further, blockchain could serve as a vital tool to secure internet networks, reduce manipulations, and enhance investment security via smart contracts (Kshetri, 2017). Additionally, its deployment could bring innovation to numerous processes and bring competitive advantages to organisations (Farnoush et al. 2022).

Blockchain also holds the potential to alter existing business models (Rajnak & Puschmann, 2021). Given the current climate where sustainability will be central in value creation for businesses, and the anticipated transformation in banking operations to accommodate not only the need for profit but also for development and social impact (Coetzee, 2018), blockchain stands to benefit those excluded from traditional financial systems. Within the financial sphere, the role of digital finance to foster sustainable development through the optimisation and modernisation of a less socially and environmentally impactful productive structure aligns with the concept of Sustainable Finance.

In response to these challenges, Parmentola et al. (2022) studied the relationship between blockchain adoption and the natural environment. Given that governments recognise blockchain's potential to positively influence the Sustainable Development Goals (SDGs), they addressed a variety of environmental sustainability challenges. However, Sustainable Finance is not confined to environmental issues, and the field dubbed Green Finance also encompasses social, economic, and environmental goals.

Although there has been a rising number of studies on the concept and ideas linked to blockchain technology, its practical exploration remains in its infancy. This is largely due to a scarcity of studies on real-world applications, such as those probing how businesses attempting to adopt blockchain differ from those ambivalent towards this technology. Farnoush et al. (2022) argue that, as a result, clarity on the potential of this technology is lacking, and a gap exists between the business value promised and the one realised by blockchain.

Considering that the technology presents opportunities to create a more sustainable world, aligned with the SDGs, this study seeks to answer the following question: How is the literature on cryptocurrencies and blockchain addressing Sustainable Finance and the SDGs related to the social and economic dimension of the 2030 Agenda?

Therefore, this study aims to identify how the literature on cryptocurrencies and blockchain addresses Sustainable Finance, focusing on the SDGs related to the social and economic dimension of the 2030 Agenda. This research may contribute to a better understanding of how blockchain technology and cryptocurrencies can assist in promoting Sustainable Finance and achieving the SDGs.

Furthermore, the research results brought several contributions. On a social level, the study aims to promote Sustainable Finance, aligned with the SDGs, thus contributing towards a fairer and more sustainable economy. On a theoretical level, this study offers an analysis of existing theoretical approaches and presents new perspectives and ideas, contributing to the development of a more robust and comprehensive theory on the subject. Lastly, on a practical level, this study provides useful information for companies and investors interested in Sustainable Finance, identifying the opportunities and challenges presented by cryptocurrencies and blockchain for promoting Sustainable Finance. Consequently, this study has the potential to provide significant contributions to society at large, policymakers, researchers, companies, and investors interested in Sustainable Finance.

2. Methodological Procedures

This study applies the Methodi Ordinatio methodology, a multi-criteria technique comprising nine steps to select and rank relevant scientific articles (Pagani et al., 2017). According to Okoli et al. (2019), this technique optimises time, energy, and costs expended in systematic reviews. The method uses the Index Ordinatio (InOrdinatio) equation to classify articles based on impact factor, number of citations, and year of publication (Pagani et al., 2017).

The current study focuses on how literature on cryptocurrencies addresses Sustainable Finance and the SDGs related specific to the economic and social dimensions of the 2030 Agenda (SDGs 1, 2, 3, 4, 5, 8, 9, 10, and 17). This complements the study by Parmentola et al. (2022) dealing with SDGs related to the environmental dimension. An initial database search took place to validate the keywords for use.

Upon defining the problem, the researchers established the key terms upon which the descriptor assembly was based, divided into three columns separated by research areas of interest. As column additions occur, the search narrows, with a maximum of three subject columns recommended (Medeiros et al., 2015). In Block 1, related to Blockchain Technology/Crypto assets, the terms Bitcoin, Ethereum, and Cardano were included, the latter known for promoting technological and economic inclusion in African countries (McGregor, 2021).

For each SDG, related keywords were listed, from which the corresponding descriptors were developed in Block 2. Block 3 inserted a filter to capture finance-focused articles. The (*) symbol was applied to capture term variations, such as "cryptocurrency" or "cryptocurrencies", "finance" or "financial", "investing" or "investment". Boolean terms were used to join the groups to create the search descriptor, and for better control and transparency, the process was repeated for each SDG, as per Table 1. The chosen database was the Web of Science (WoS), due to its scientific relevance and breadth. The search yielded 258 articles, exported in Bibtex and Excel. After removing 30 duplicates and 37 conference/review articles and editorials, 185 articles remained.

The JCR index, provided by SCImago, was used as the metric for the journal impact factor. Finally, the InOrdinatio Equation (1) was applied, assigning a value of 5 to alpha, considering that the recency of articles is not dominant for their selection.

$$InOrdinatio(i) = (IF/1000) + \alpha * [10 - (ResearchYear - PublishYear] + (\sum Ci) \quad (1)$$

Where: IF is the impact factor (For articles without an impact factor, a value of 0 was assigned); α is a weighting factor ranging from 1 to 10, to be assigned by the researcher; ResearchYear is the year when the research was developed; PublishYear is the year when the article was published; and ∑ Ci is the number of times the article i was cited.

Table 1: Constructs used in the search and number of articles recovered from the Web of Science database.

SDG	Block 1	Block 2	Block 3	n
1	Crypto-currenc* OR block-chain OR Bitcoin OR toke-nizat* OR Cardano OR Ethe-reum	"Poverty" OR "social protection systems" OR "economic resources" OR "basic services"	Fi-nanc* OR in-vest*	36
2		"hunger" OR "food security" OR "land quality" OR "soil quality" OR "maintain ecosystems" OR "genetic resources" OR "agricultural research" OR "traditional knowledge" OR "food reserves"		25
3		"Good Health" OR "well-being" OR "substance abuse" OR "health coverage" OR "financial risk protection"		29
4		"quality education" OR "childhood development" OR "affordable education" OR "achieve literacy" OR "cultural diversity" OR "inclusivity environment" OR "learning environment"		12
5		"discrimination" OR "violence" OR "harmful practices" OR "leader-ship" OR "sexual health" OR "reproductive health" OR "reproduce-tive rights" OR "empowerment of women" OR "gender equality"		90
8		"per capita growth" OR "economic diversity" OR "development-oriented policies" OR "sustainable growth" OR "productive work" OR "decent work" OR "forced labour" OR "slavery" OR "human traffic" OR "child labour"		14
9		"resilient infrastructure" OR "inclusive industrialization" OR "sustainable industrialization" OR "value chains" OR "upgrade infrastructure" OR "retrofit industries" OR "domestic technology development"		18
10		"equal opportunity" OR "equalities of outcome" OR "wage policies" OR "social protection" OR "migration policies" OR "official assistance" OR "financial flows"		15
17		Partnership* OR "resource mobilization" OR "promotion regimes" OR "international capacity-building" OR "macroeconomic stability" OR "coherence for development"		19

Source: Own elaboration

For the software analysis, the researchers considered the 185 selected articles, while for reading and systematic analysis, they selected the top 82 articles with the highest impact. After article selection, abstract content, titles, keywords, and their semantic relations underwent quantitative and qualitative analysis through the KH Coder. This software processes texts and uses co-occurrence analysis methods and network analysis to infer proximity between words (Higuchi, 2016).

The Stanford POS Tagger system was used for word recognition. From the list of words generated by the software and their respective frequencies, the researchers gathered the central terms of the summaries, as shown in Table 2. Thus, they could investigate the concepts contained in the data by looking at groups of words appearing together or groups with the same words, from co-occurrence matrices and identified semantic networks.

Table 2: Coding of SDGs for the KHCoder

ODS 1	poverty or social+protection or economic+resources or basic+services
ODS 2	hunger or food+safity or food+security or land+quality or soil+quality or maintain+ecosystems or genetic+resources or agricultural or food+reserves or traditional+knowledge
ODS 3	good+health or well+being or substance+abuse or medicine or financial+risk+protection
ODS 4	quality+education or childhood or education or achieve+literacy or cultural+diversity or inclusivity+environment or learning+environment
ODS 5	((discrimination or violence or leadership or empowerment) & (gender or woman or femaly or sexual)) or harmful+practices or leadership+position or sexual+health or reproductive+health or

	reproductive+rights or gender+equality or ((gender or woman or femaly or sexual) & equality or leadership+position)
ODS 8	per+capita+growth or economic+diversity or development+oriented+policies or sustainable+growth or productive+work or decent+work or forced+labour or slavery or human+traffic or child+labour
ODS 9	((resilient or upgrade) & infrastructure) or ((sustainable or inclusive) & industrialization) or value+chains or retrofit+industries or domestic+technology+development or (access & innovation) or comunication+technology
ODS 10	inclusion or equal+opportunity or (equalities & outcome) or wage+policies or social+protection or migration+policies or official+assistance or financial+flows
ODS 17	partnership or resource+mobilization or promotion+regimes or international+capacity+building or macroeconomic+stability or (coherence & development)

Source: Research data

3. Results and Discussions

3.1 Descriptive Analysis

The descriptive analysis of the 185 chosen papers was carried out to identify challenges and future trends. The year of publication, journal, field of study, country, citations, and methodological approach were examined.

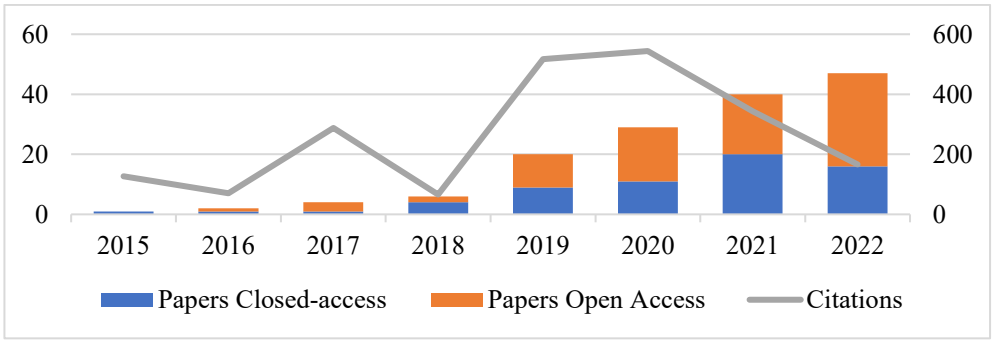


Figure 1: Evolution of publications and citations in the examined period.
Source: Research data

Figure 1 delineates the trajectory of publication and citation volumes from 2015 to 2022. The output regarding the subject matter increased from 2019 onwards, and it was only in 2022 that the majority of publications became openly accessible. It was also observed that there was a rise in the number of citations from 2019, indicating a growing interest in this area of study. Due to the diversity of technologies implicated in blockchain, several fields of study are represented (Figure 2). The data reveals that more than half of the studies focus on the fields of "Business and Economy" (19%), "Computer Science" (18%), and "Engineering" (15%). Following these are "Telecommunications" at 10%, "Environmental and Ecological Sciences" at 9%, and "Science and Technology - Other Topics" at 8%.

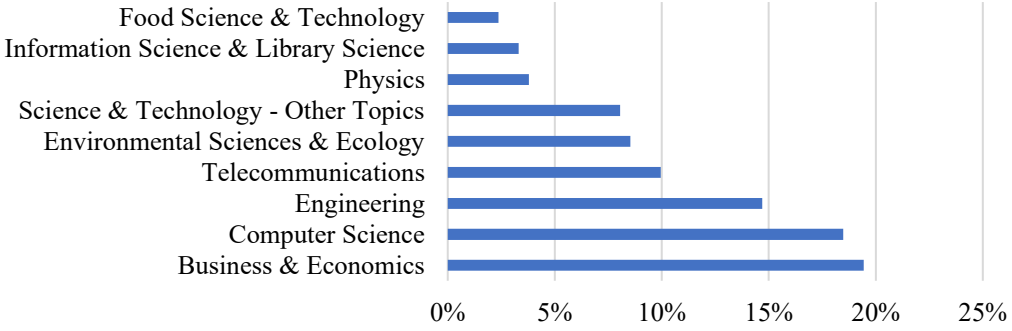


Figure 2: Research Area
Source: Research data

Figure 3 depicts the distribution of bibliographic coupling by journals. The minimum number of documents from a considered source was three, all of which have an impact factor, barring the journal Frontiers In Blockchain, which has yet to be ranked by the SCImago Journal Rank (SJR). The ranking implies that all the journals are of high quality, suggesting that the subject matter is prominent and appealing to major publishers.

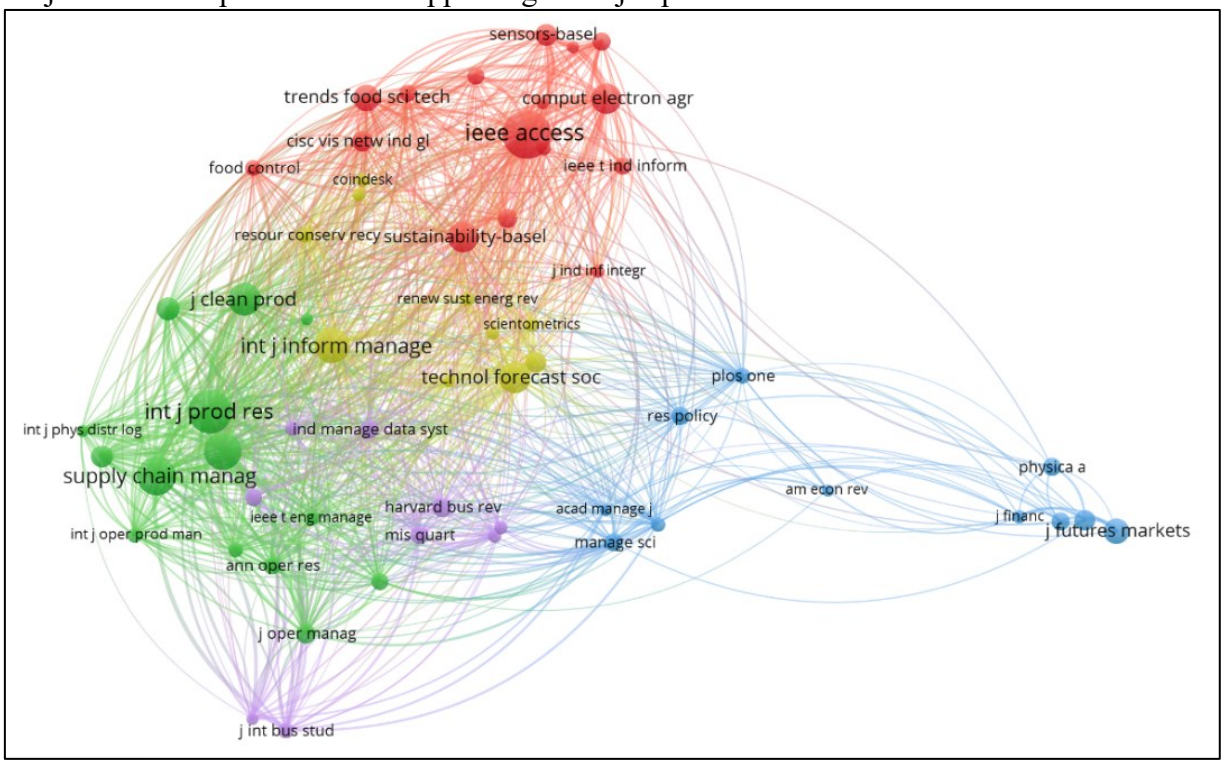


Figure 3: Journal Contribution (VOSviewer)
Source: Research data

Additionally, the data exhibits the score and ranking of the 12 most cited journals, highlighting the quantity of papers and citations analysed (Table 3).

Table 3: Scores and ranking of the 12 most cited journals

Source	Publisher	Articles	Citations	SJR
Ieee Access	IEEE	9	144	0.927
Journal Of Financial Stability	Elsevier	2	142	1.657
Supply Chain Management	Emerald	2	128	2.385
Trends In Food Science & Technology	Elsevier	2	117	2.402
Sustainability	MDPI	11	111	0.664
Electronics	MDPI	2	89	0.59
Ieee Transactions on Mobile Computing	Ieee Computer	2	10	1.276
Applied Sciences-Basel	MDPI	2	9	0.507
Future Internet	MDPI	2	9	0.793
Frontiers In Blockchain	Frontiers Media	3	7	-
Strategic Change	John Wiley & Sons	2	6	0.497
Journal Of Global Information Management	Igi Global	3	2	0.469

Source: Research data

Another significant analysis of the study was to ascertain the origin of the research (Figure 4). Despite many papers being the result of international collaborations and authors from diverse locations, the distribution by nationality enables the identification of certain

patterns. China stands out as the most active country in this field, likely due to projects already conducted, thereby establishing itself as a major nation on the subject.

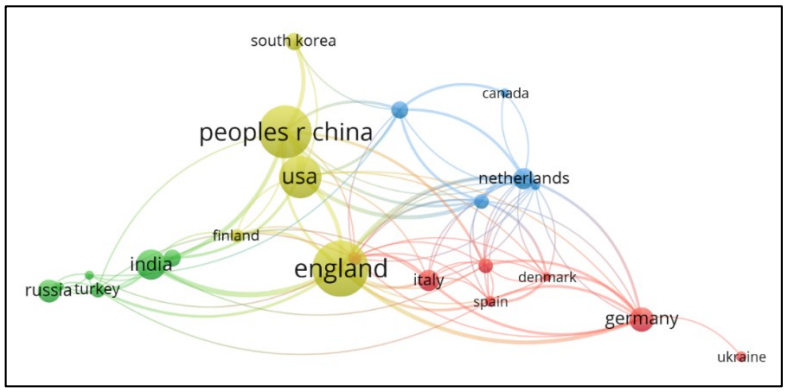


Figure 4: Contribution by countries (VOSviewer)
Source: Research data

3.2 Research trend analysis

In this section, a keyword co-occurrence analysis is conducted, a bibliometric method employed to map the research field. The objective of generating this analysis was to identify the key research fronts in blockchain that pertain to Sustainable Finance. The keywords from all the papers were considered, establishing an occurrence attribute equal to 3 for the keywords. The phrases most cited in the papers that constitute this research sample were: “blockchain technology” (99), “technology” (30), “bitcoin” (20), “management” (19), “internet” (16), “challenges” (16), and “system” (14).

In Figure 5, the node sizes represent the keyword occurrence frequency, while the lines demonstrate the relations between keywords.

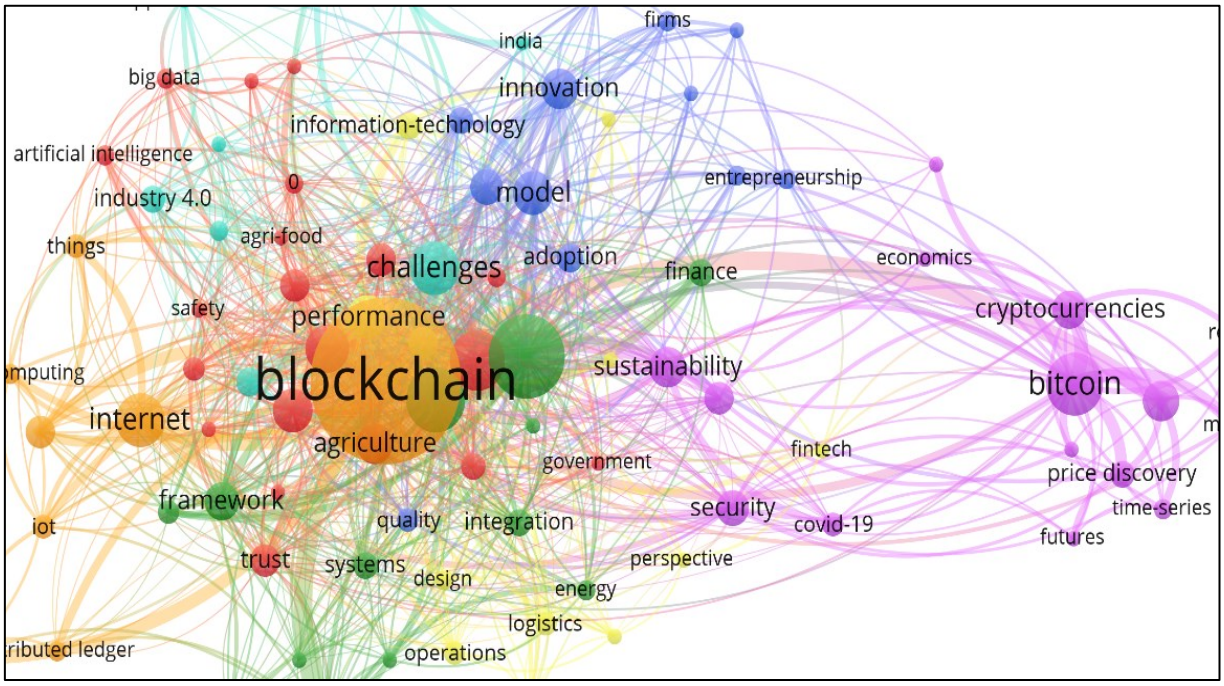


Figure 5: Co-occurrence Analysis (VOSviewer)
Source: Research data

The map displays the combinations of keywords that frequently appear in the 'blockchain' macrotheme. Co-occurrences are used to understand the underlying patterns of the document set under examination. The network visualisation identified a modular network

characterised by seven distinct but interrelated clusters. A cluster is a group of keywords that have co-occurrence relations. In particular, Table 4 summarises the significant items from the co-occurrence analysis, while the prominent results and research queries from each cluster are presented below.

Table 4: Clusters and key terms

Clusters	Nº of itens	Label	Cluster details
Cluster 1 (Red)	29	Agri-food Sector	agri-food, agriculture, artificial intelligence, big data, case study, food security, food supply chain, government, ict, machine learning, management, precision agriculture, safety, supply chain, supply chains, system, traceability, transparency, trust
Cluster 2 (Purple)	28	Digital Currency	bitcoin, covid-19, cryptocurrencies, cryptocurrency, digital economy, economics, futures, information, money, price discovery, return, security, sustainability, time-series, transfer entropy
Cluster 3 (Green)	37	Strategic Value	blockchain technology, energy, finance, framework, industry, information, integration, investment, knowledge, smart contracts, systems, technology, uncertainty
Cluster 4 (Yellow)	17	Logistics Coordination	coordination, design, fintech, governance, information-technology, leadership, logistics, networks, operations, performance, perspective, unified theory
Cluster 5 (Blue)	23	Digital Social Innovation	adoption, capabilities, digitalization, entrepreneurship, financial inclusion, firms impact, innovation, institutional theory, model, poverty, quality
Cluster 6 (Turquoise)	5	Industry 4.0	artificial-intelligence, big data analytics, challenges, digital technologies, future, india, industry 4.0, opportunities, supply chain management
Cluster 7 (Orange)	9	Block-chain Techno-logies	blockchain, cloud computing, distributed ledger, internet, internet of things, iot, smart contract, things

Source: Own elaboration

Cluster 1 focuses on the **agri-food sector**, important due to the demand for sustainable, accessible, secure and sufficient supply of food and other consumer goods. Thus, blockchain technology has the potential to improve the management of this chain in aspects such as traceability, information security, manufacturing and sustainable water management (Zhao et al., 2019; Kayikci et al., 2022). It can also facilitate visibility in supply chains, making products more viable for consumers willing to pay the necessary premium to fund the technology (Rogerson & Parry, 2020). Moreover, the technology can provide greater accessibility, visibility, and empowerment for sustainable supply chains and for often overlooked actors such as small farmers (Quayson, Bai & Sarkis, 2021).

Cluster 2 addresses **digital currency** and financial management. Digital currency, through the use of blockchain technology, advocates benefits such as efficiency, transparency, cost reduction, and greater financial inclusion. These attributes align with various Sustainable Development Goals (SDGs), including SDG 1 (Poverty Eradication), SDG 8 (Decent Work and Economic Growth), and SDG 10 (Reduction of Inequalities).

The adoption of digital money via blockchain technology plays a role in the financial inclusion of the unbanked populations or those with limited access to traditional financial services. This approach could impact the lives of millions of people positively without access to traditional banking services, advancing towards SDG 1 and SDG 10 (Kim and Shin, 2019). Furthermore, the efficiency and transparency offered by this innovation may stimulate economic growth and the creation of quality jobs, supporting SDG 8.

Another aspect of digital money connects with the financial sector, which faces challenges with the emergence of these technologies, whose potential to cause disruption. Khan et al. (2022) argued that tokenising debt instruments used for project financing or portfolio diversification reduces disintermediation and automation costs, increases efficiency, and improves transparency, thereby reducing liquidity requirements.

Cluster 3 relates to **strategic value**. Blockchain combines public/private key cryptography, cryptographic hash functions, and database technologies to achieve traceability, transparency, security, and protection. This combination enables permanent transaction records grouped into individual blocks that cannot be tampered with, replacing traditional paper tracking systems and manual monitoring, and avoiding imprecise impacts on the value chain (Zhao et al., 2019).

Furthermore, blockchain as a strategic value can eliminate intermediaries (Kayikci et al., 2022), and facilitate collaboration between businesses through greater visibility as perceived by supply chain professionals (Rogerson and Parry, 2020). In short, it presents itself as a promising tool in creating strategic value because these improvements in traceability, transparency, security, and information protection, combined with the elimination of intermediaries, allowing businesses to leverage their efficiency and trust in processes and decision-making, generating competitive advantages in the market, and improving their overall performance.

Cluster 4 refers to **logistics coordination**, which is enhanced by the use of blockchain technology, with greater efficiency, effectiveness, and reliability in supply chain partnership processes (Kim & Shin, 2019). Its technical characteristics allow collaboration between chain partners to reconcile demand and supply, optimising benefits and mitigating risks. Additionally, increased reliability in the supply chain improves the traceability, authenticity, and legitimacy of products (Hew et al., 2020). In a food supply chain, blockchain can be adopted in all processes, including transport and storage, contributing to product demand and productivity improvement (Mangla et al., 2021). In this sense, the adoption of this technology aids in achieving the SDGs, such as SDG 8 of economic growth and SDG 9 of innovation and infrastructure.

Cluster 5, as a **digital social innovation**, has potential to promote financial inclusion and contribute to the SDGs (Farnoush et al., 2022; Quayson, Bai, & Sarkis 2021; Prasad et al., 2018). This innovation is considered one of the most important and revolutionary in the technological space, with potential to shape the future by improving the social conditions of the less privileged in various sectors, such as the supply chain and responsible consumption and production, aligning with SDGs 9 and 12.

In some contexts in emerging economies, there are difficulties in understanding and using blockchain for the social sustainability of the supply chain (Quayson, Bai, & Sarkis 2021). However, overcoming some barriers such as age, education, poverty, and technological skills, can provide advances in social conditions by improving sustainability and the inclusion of these small producers, transforming the conduct of business (Prasad et al., 2018). In this way, the ability to exchange value directly via the internet, without intermediaries and with less friction in terms of cost, delays, and risks, makes it a high-impact innovation with user involvement.

Cluster 6 refers to **industry**. The transition to a digital twin-based infrastructure in industry is inevitable due to the precision and effectiveness provided by enabling technologies, the standardisation of the Internet of Things (IoT), Artificial Intelligence (AI), and blockchain 3.0. As part of the Fourth Industrial Revolution movement, these technologies are changing how consumers make decisions regarding health, education, finance, among other aspects (Boninsegni et al., 2022; Teng et al. 2021)

According to Al Azmi et al., (2022), blockchain solutions can benefit the global economy because by bringing the technology to the industry, it is possible to obtain a solution

for supply chain resilience and promote long-term sustainable growth. By promoting innovation and efficiency in industrial processes, blockchain has the potential to transform the "factories of the future" into sustainable, consistent, and scalable ventures, allowing industries to meet global demands in an environmentally conscious and socially responsible way.

Cluster 7, blockchain **technologies**, is fundamental for business management. The technology has various applications that transcend financial boundaries and asset transfers. Teng et al. (2021) present a variety of successful operating systems based on blockchain, such as bill payment and reward systems using cryptocurrency, peer-to-peer energy trading markets, energy market imbalance settlement, IoT-enabled platforms, and blockchain-enhanced smart metering, certification systems, and applications in electric vehicles, among others.

On the other hand, Zhao et al. (2019) highlight the relevance of blockchain technology to ensure data integrity, prevent tampering, provide immutability, and complete traceability of transaction records stored across the entire agri-food chain. The IoT ecosystem is another sector that benefits from the application of blockchain. Kshetri (2017) points out that, in many respects, blockchain-based solutions are superior to centralized cloud server systems as they offer greater robustness, cybersecurity, and privacy protection. They also ensure the accountability of parties involved in general transactions.

3.3 Blockchain's Contribution to SDGs

Subsequent to the cluster analysis, the research papers were examined to connect the applicability of Blockchain technology to each of the SDGs and to reveal potentialities and challenges (Table 5). Upon review, 12 papers were discarded owing to lack of congruence with the scope of the research, whether in relation to cryptocurrencies/blockchain or the SDGs. This initial human classification was refined using the KH Coder Crosstab tool, which encoded the relationship of the abstracts with the SDGs, utilising the terms set forth in Table 2.

Following analysis, SDG 9 related to Industry, Innovation, and Infrastructure showed the highest alignment, followed by SDG 17 on partnerships. All other SDGs were represented to a greater or lesser degree, except for SDG 5 on Gender Equality which was not identified in the initial reading of the 82 papers. It was noted that the term "leadership" was the chief culprit for various false positives, and that the bulk of the papers associated with the SDGs dealt with blockchain technologies (112 papers), whereas 42 discussed cryptocurrencies.

After this preliminary analysis, a co-occurrence analysis was undertaken of the Blockchain technology with each of the SDGs set forth in the methodology (Figures 6, 7, 8, 9, 10, 11, 12, 13, and 14). Figure 6 presents the co-occurrences of SDG 1 in conjunction with Blockchain technology. In this analysis, 13 concurrency groups were identified.

The SDG 1 co-occurrence network suggests debates centered around matters pertaining to poverty eradication and promotion of economic prosperity. Terms such as "poverty", "services", "social", "income", and "equality" feature prominently in the network and may point to discussions concerning financial inclusion, financial innovations, and emergent technologies that may benefit the accomplishment of SDG 1 targets. It is feasible to infer that this technology can be viewed as a potential tool to confront challenges linked to poverty and inequality via the promotion of more inclusive and transparent financial systems, thereby contributing to the enhancement of access to financial services and the empowerment of more vulnerable populations, goals established by SDG 1.

The literature concerning cryptocurrencies addresses facets related to SDG 1 in a multidisciplinary fashion, considering public policies, technological platforms, collective endeavours, and the relation to poverty. Moreover, cryptocurrencies are viewed as a potential tool to assist in achieving the goals of poverty eradication and social protection.

Quayson, Bai, and Sarkis (2021) highlight the precarious subsistence of small farmers in the cocoa supply chain of emerging economies, resulting from fraud, exploitation, corruption,

deceit, child labour, and financial exclusion. These authors maintain that Blockchain technology can rectify the inefficiencies, complexities, and other societal issues faced by small farmers in the supply chain. It is emphasised, nonetheless, that the potential of the technology in mitigating the vulnerability of these producers in the cocoa supply chain remains underexplored in emerging economies.

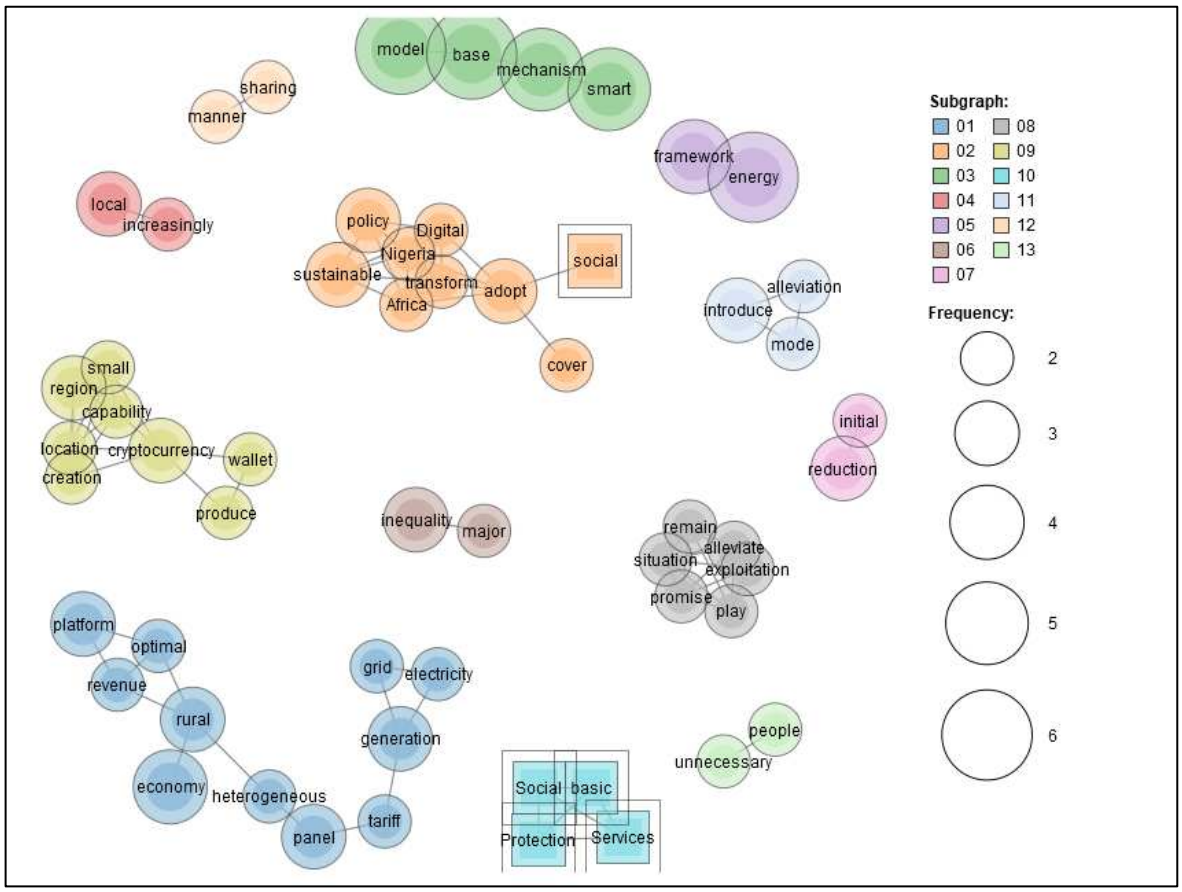


Figure 6: Word co-occurrence network pertaining to SDG1 (KHCoder).

Contrarily, Howson & Vries (2022) argue that the unsustainable trajectory of some cryptocurrencies disproportionately impacts poor and vulnerable communities. In these contexts, cryptocurrency producers and other actors benefit from economic instabilities, weak regulations, and access to cheap energy and other resources. As per this study, mass adoption of bitcoin technology will result in a burgeoning climate crisis, exacerbating social and environmental challenges for communities afflicted by multiple dimensions of deprivation.

Jirasek (2022), on the other hand, addresses the evolution of traditional gaming communities to cryptographic games. The author contrasts these communities and indicates that cryptographic gaming communities have established themselves as organisations focused on profit acquisition. By targeting players from developing countries, they offer them the possibility to earn income without the necessity to invest resources to participate in lucrative games. While positive reports exist of individuals who have overcome poverty or risen in the hierarchies of their communities, there is a dark side: cryptographic gaming communities provide ample opportunities for ethical criticism and questioning.

Figure 7 illustrates the co-occurrences related to SDG2, whose goal is "Zero Hunger", demonstrating the interconnection between the key terms and SDG 2, identifying 16 subgroups. It is observed that technology and innovation in the agricultural and food sector contributes to the sustainability and efficiency of production. The presence of words like “food”, “hunger” and “security” signifies concern for food security, addressing the challenge of hunger and

ensuring access to nutritious and sufficient food for all. Additionally, the terms “land” and “quality” underline the need to manage natural resources, such as lands, sustainably to maintain productive capacity and minimise environmental impacts.

Kor, Krwczyk & Wakkee (2022) emphasise food waste as a challenge confronting humanity. There is an escalating interest in the prevention of this waste due to global hunger, resource scarcity, environmental impacts, and economic costs. The authors assert that curbing food loss throughout the supply chain is a formidable challenge, and the adoption of blockchain technology may assist in addressing pivotal issues such as traceability, trust, and accountability within the food industry.

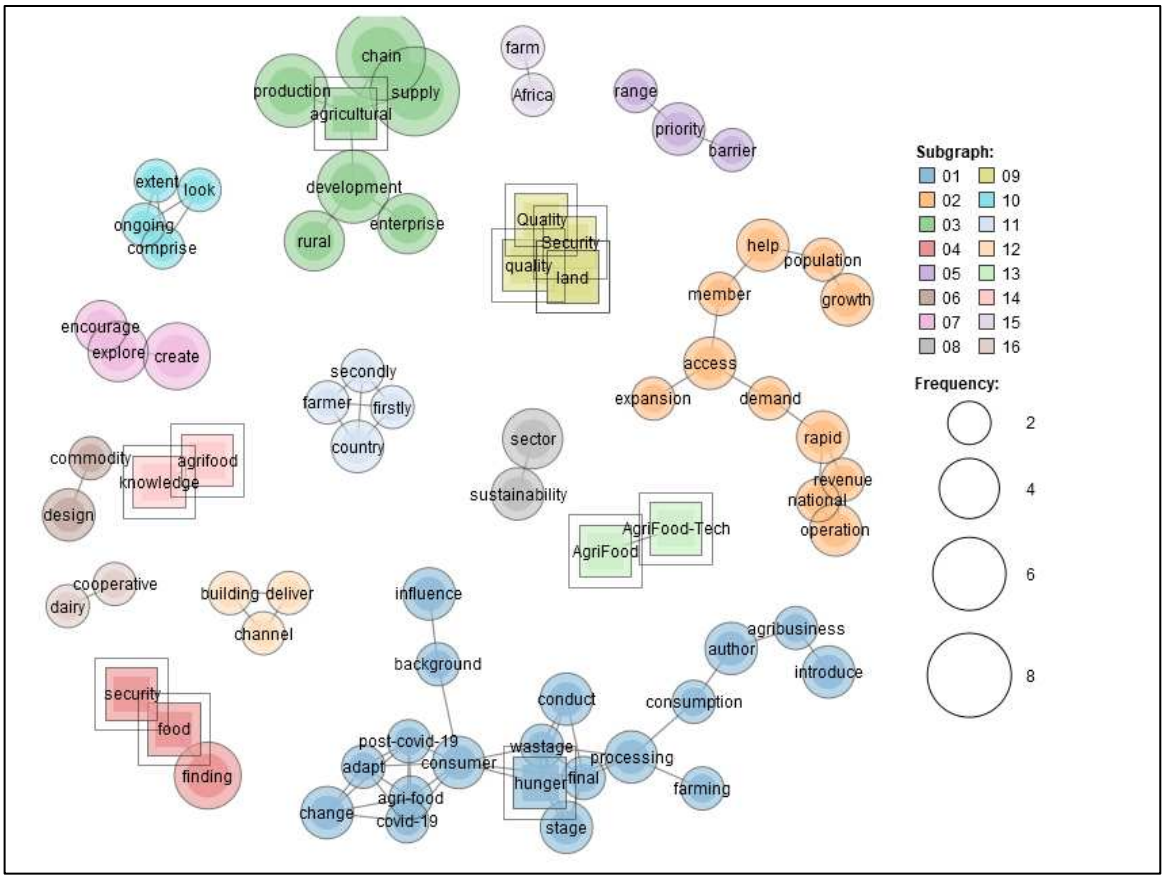


Figure 7: Word co-occurrence network pertaining to SDG2 (KHCoder).

Galanakis et al. (2021), in turn, explored potential innovations during the COVID-19 crisis, framing them within the themes of the food sector such as food security, bioactive compounds, and sustainability, directly affected by the pandemic. The authors concluded that blockchain is among the technologies with the greatest potential in this new era.

Addressing the issue of inequality in access to resources and agricultural technologies, to achieve the goals set out by SDG 2, is crucial to ensure that small producers and vulnerable communities benefit from these innovations and have access to information, financial services, and markets. These outcomes reiterate the importance of inclusion and equity in the agricultural sector and emphasize the role of blockchain technology and other innovative solutions in promoting sustainable development and fighting hunger. Moreover, cooperation and partnerships among governments, international organisations, and the private sector are crucial to ensuring food and nutritional security worldwide, as well as to addressing socio-environmental challenges related to agriculture.

Figure 8 presents the co-occurrences related to SDG 3 of health and well-being. The data highlight the emphasis on electronic health and the promotion of general health, with the

presence of terms such as "eHealth" and "health". eHealth refers to the use of information and communication technologies (ICT) in the health sector to enhance the efficiency, quality, and accessibility of health services. This directly relates to SDG 3, as eHealth can assist in achieving goals such as reducing maternal and child mortality, combating non-communicable diseases, and ensuring universal access to sexual and reproductive health.

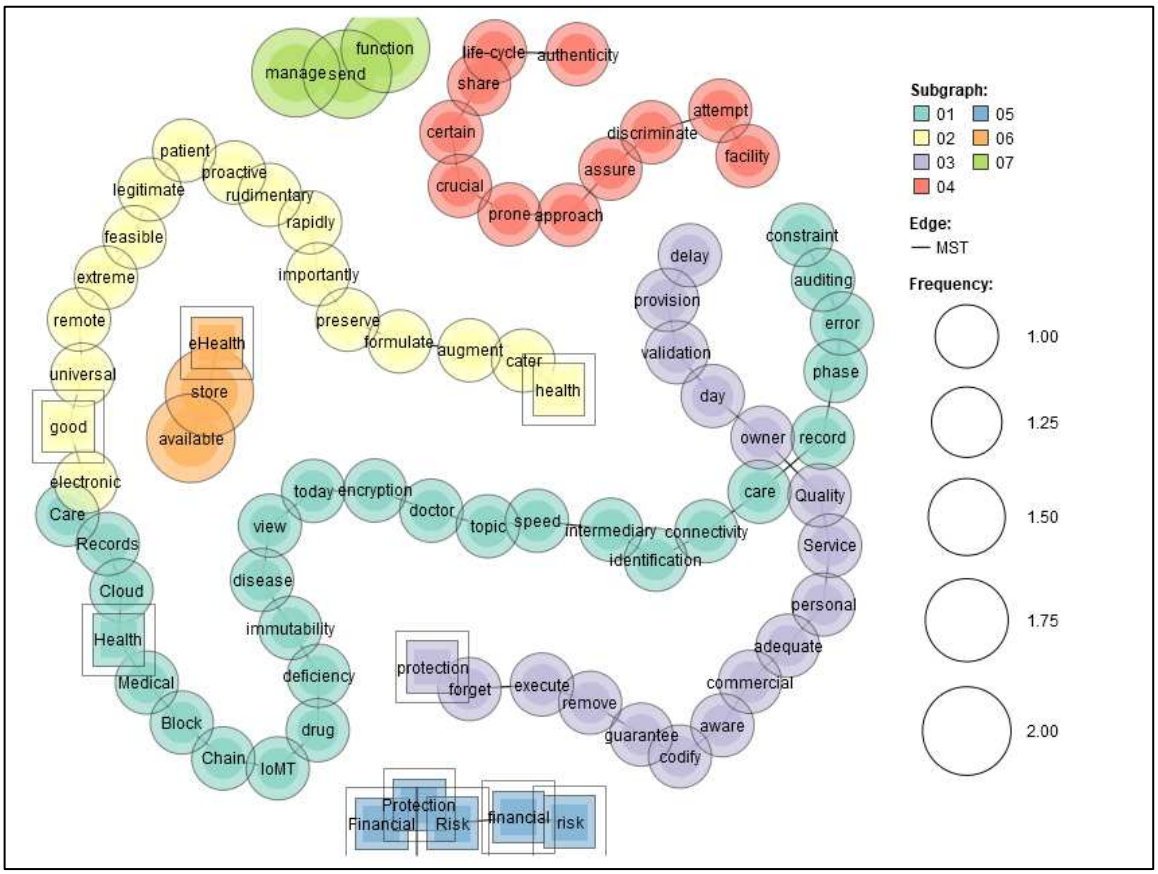


Figure 8: Co-occurrence network of words referring to SDG 3 (KHCoder).

Aboamer et al. (2022) posit that the convolutional neural network (CNN) and blockchain technology are two important parts that, when combined, can enhance secure disease detection procedures, such as lung cancer, as well as make food safer. In alignment with this idea, Khatoom (2020) proposes multiple workflows involved in the health ecosystem utilising blockchain technology for better data management. According to the study, medical workflows were designed and implemented using the Ethereum blockchain platform, encompassing complex medical procedures such as surgeries and clinical trials.

The terms "financial" and "protection" denote the importance of financial support and protection in the health context. This may relate to the need for robust and accessible health systems, as well as protection against catastrophic health-related financial risks. These terms reflect the concern with ensuring universal health access, minimising inequalities and protecting individuals from poverty due to medical expenses.

Lastly, the term "risk" underscores the significance of health risks and the need to manage them effectively. This may include the identification of risk factors, disease prevention and control, and the promotion of healthy lifestyles.

The analysed co-occurrence network indicates that the papers are exploring the potential of blockchain to enhance the quality and accessibility of health services, while tackling challenges related to security, privacy, and regulatory compliance. This suggests the relevance

of the discussion on using blockchain as a promising tool in striving for the realisation of the goals of SDG 3.

Figure 9 relates to SDG 4 "Quality Education" and presents various co-occurrences. The analysis provides insights into how SDG 4 is addressed in scientific papers. The connections between the terms “cultural”, “diversity”, “education” and “learning” underline the importance of inclusion and respect for cultural diversity in education, as well as the necessity to guarantee inclusive and equitable education for all. Additionally, the term “environment” suggests the importance of creating appropriate learning environments and promoting environmental awareness in education, directly aligned with SDG 4.

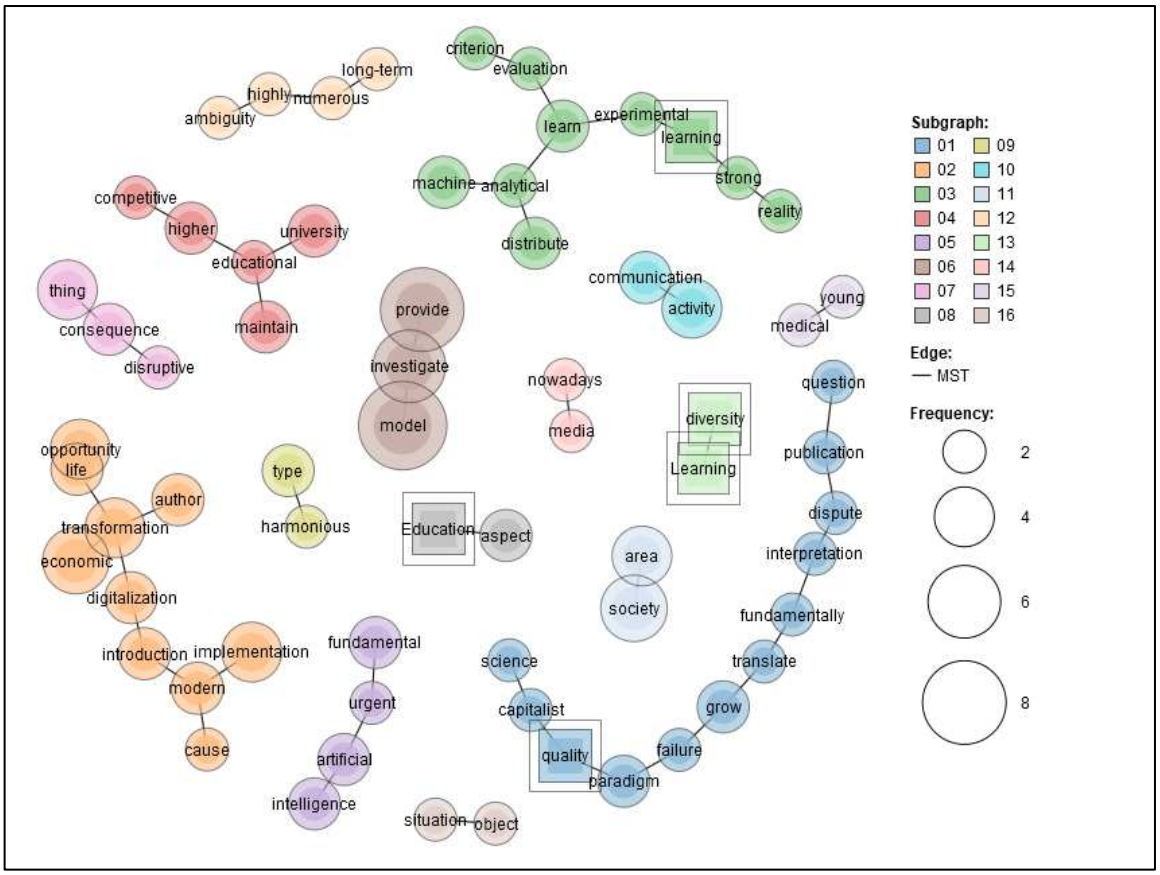


Figure 9: Co-occurrence network of words referring to SDG 4 (KHCoder).

Another aspect of this analysis is the role of technology in promoting quality education. The presence of terms such as “Artificial Intelligence” (AI) indicates that the papers are exploring the potential of emerging technologies to enhance educational processes. These findings point to the growing interest at the intersection between technology and education, and reinforce the need to continue investigating and developing innovative solutions to confront the challenges of 21st-century education, in alignment with SDG 4.

Farnoush et al. (2022) contend that blockchain is an emerging and revolutionary technology that will bring innovation to various processes, acting as an ally in promoting solutions that guarantee transparency in the distribution of educational resources, combating corruption, tracking and ensuring the origin and authenticity of documents, as well as in combating piracy and counterfeiting, thus contributing to the quality and accessibility of education.

In this context, Kholiavko et al. (2021) identified the main informational threats present in the digitisation of higher education, related to the protection of personal data and security against attacks and fraud. The authors detailed strategic measures to ensure the adaptability of

higher education to the digital economy. Meanwhile, Shaikh et al. (2022) designed and developed an analytical accreditation model to investigate individual credentials collected from universities and examine the credibility records of candidates.

Both studies demonstrate the potential of blockchain technology in the educational context. By providing increased security, transparency, and traceability, this technology can help tackle challenges related to personal data protection, fraud prevention, and ensuring teaching quality. Furthermore, the implementation of blockchain can contribute to the democratisation of access to education, making it more inclusive and equitable for everyone. Thus, the literature points to the importance of blockchain technology in the education sector and its potential to promote quality and accessible education, reinforcing the relevance of discussions around SDG 4 and its goals.

Figure 10 represents SDG 5, which aims to achieve gender equality and empower all women and girls. The analysis reveals the importance of increasing women's participation and representation in the technology sector, specifically in leadership and decision-making positions. By addressing gender inequalities and ensuring that women have access to resources, rights, and opportunities in the field of blockchain technology and cryptocurrencies, SDG 5 can be promoted.

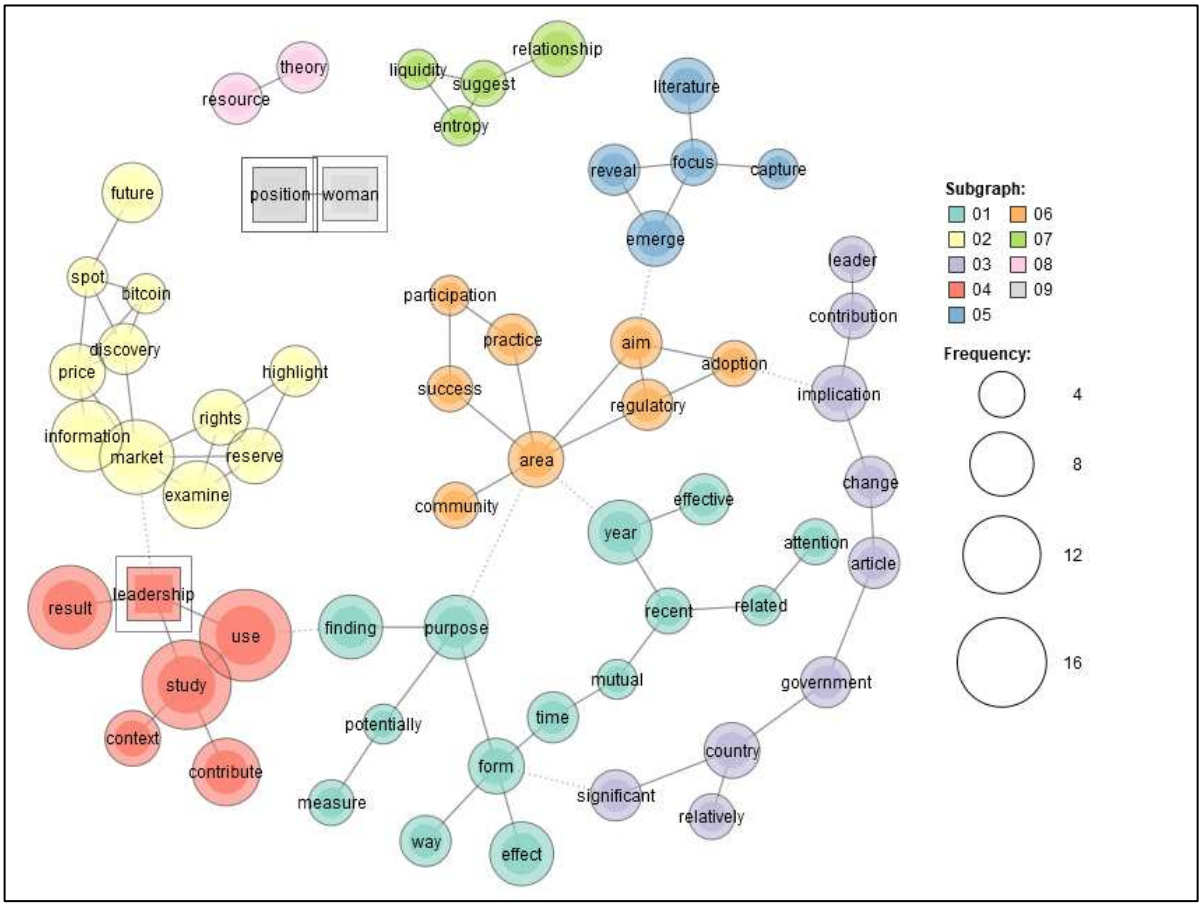


Figure 10: Co-occurrence network of words referring to SDG 5 (KHCoder).

Blockchain and cryptocurrencies have the potential to address issues of gender violence and access to resources. The technology can be used to track and combat violence, ensuring the safety and privacy of victims. Cryptocurrencies, on the other hand, can offer economic opportunities for women and girls, especially in areas with limited access to traditional financial services.

The network allows for inference of some connections, such as the relationship between the terms “leadership” and “woman”, which suggests the importance of addressing the gender gap in the technology sector. Likewise, the mention of terms such as “violence” and “position” may indicate the potential of blockchain in combating violence and promoting gender equality.

Nevertheless, amongst the selected articles, only Guzman et al., (2021) specifically address SDG 5. The authors discuss the female participation and the impact of gender diversity on the success of initial coin offerings (ICOs). Beyond this study, other articles merely graze the topic, touching upon issues such as violence, wages, and weapons, generating outcomes deemed false positives by the analytical software (Chen et al., 2021; Hoque et al., 2021; Kyzy, Dunn and Sweeney, 2022). Despite these studies not directly addressing the theme, they contribute to a broader discussion on matters related to SDG 5. In this context, it becomes crucial to consider the intersectionality among different SDGs and how research can indirectly relate to the proposed themes.

Given the scarcity of studies that specifically discuss gender equality in the context of blockchain, it is important to encourage further research in this area to better understand how technology can contribute to the promotion of gender equality and the empowerment of women and girls in various sectors of society.

Regarding SDG 8, which goals involve promoting sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all, the studies display the co-occurrences shown in Figure 11.

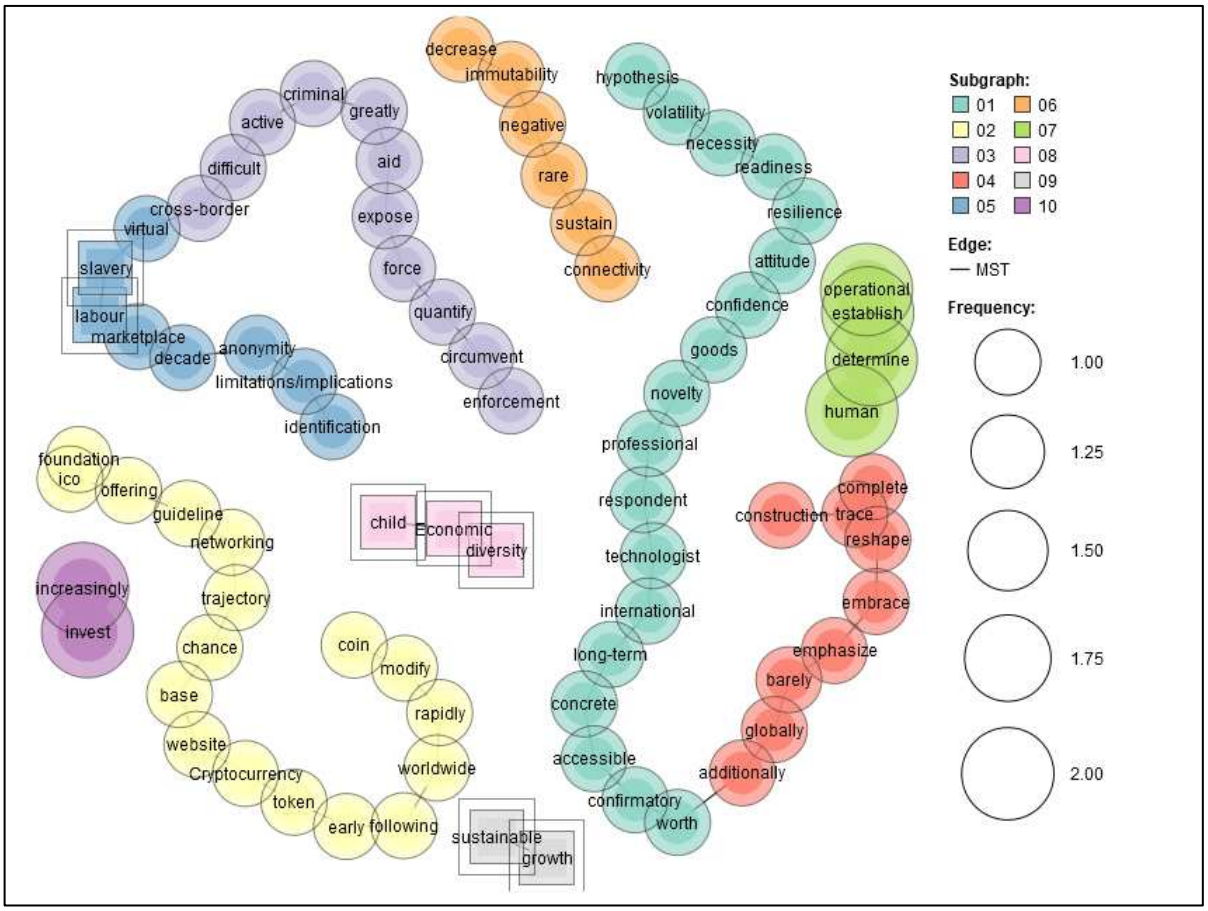


Figure 11: Co-occurrence network of words pertaining to SDG 8 (KHCoder).

The presence of the terms “growth” and “Economic” suggests that blockchain technology and cryptocurrencies have the potential to propel economic growth, both on a global and local scale. The decentralisation and transparency of this technology can contribute to the

increase in efficiency and cost reduction in various sectors, potentially leading to more sustainable economic growth.

The terms “child”, “labour” and “slavery” are related to issues of child labour and forced labour, two of the main challenges faced in the context of SDG 8. Blockchain technology can be applied to combat these practices, through systems of tracking and verification of production and supply chains, ensuring that products and services are free from child labour and forced labour.

The presence of the terms “diversity” and “sustainable” highlights the importance of addressing issues of inclusion and sustainability in the development and adoption of blockchain-based technologies and cryptocurrencies. By promoting diversity and inclusion in the technological sector, it is feasible that the developed solutions cater to the needs of diverse groups and contribute to more inclusive and sustainable economic growth.

The analysis has unveiled relationships between SDG 8, blockchain, and cryptocurrencies. The network points to the technology's potential in boosting sustainable economic growth and promoting decent work. The decentralisation and inherent transparency of this technology may lead to higher efficiency and cost reduction in various sectors, thereby contributing to more sustainable and inclusive economic development.

SDG 9, represented in Figure 12, aims to build resilient infrastructure, promote inclusive and sustainable industrialisation, and foster innovation.

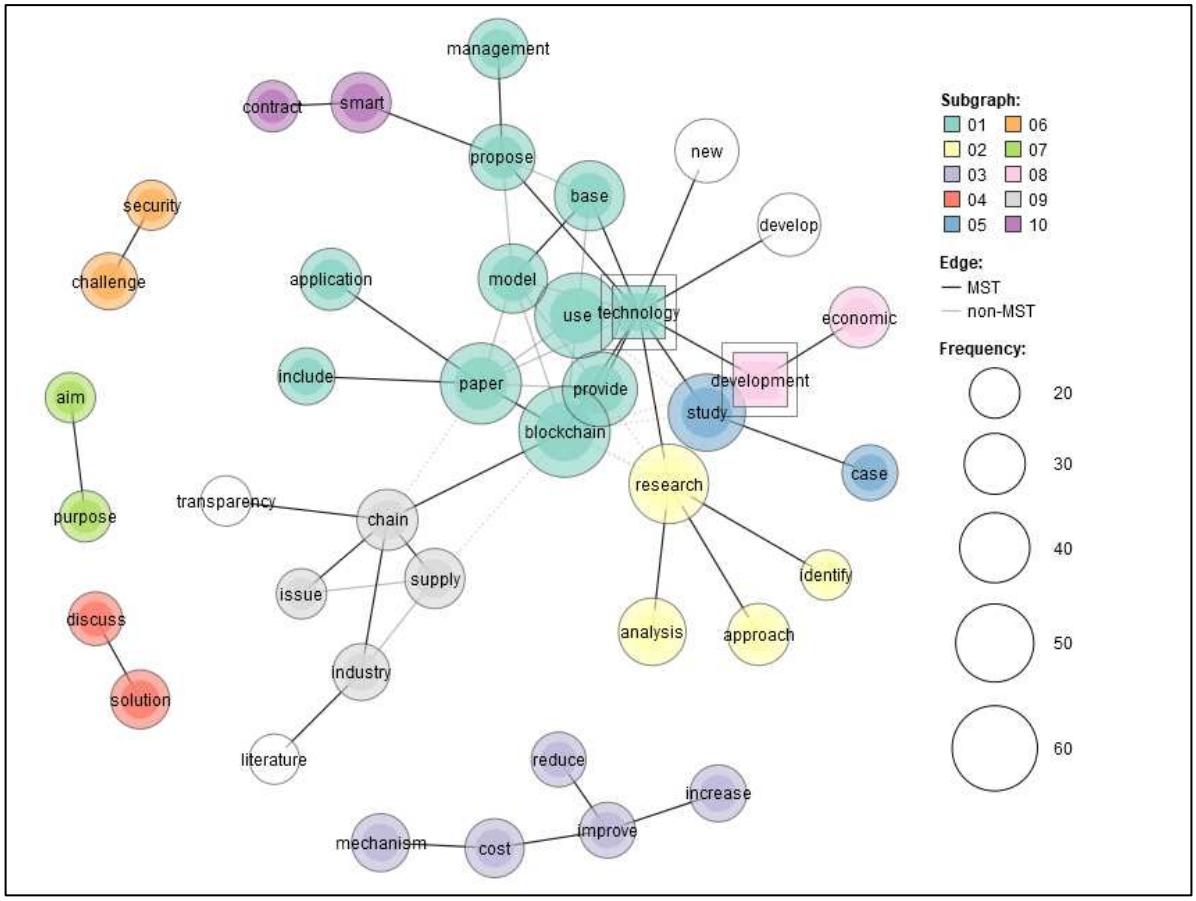


Figure 12: Co-occurrence network of words pertaining to SDG 9 (KHCoder).

The co-occurrence network illustrates the relations between the key terms associated with SDG 9 such as “development”, “innovation”, “infrastructure”, “technology”, and “access”, and highlight how related articles explore the interaction between these areas. The discussed literature shows that blockchain technology has been explored as an innovative solution in

various sectors, including the financial, public and the industry, through the use of smart contracts as an innovation that can enhance the efficiency and transparency of transactions, facilitating access to services and resources.

Farnoush et al. (2022) claim that in addition to being emerging, blockchain technology is revolutionary, and its adoption by businesses can bring various competitive benefits, such as reshaping the structure of all accessible networks in the future and improving the sustainability and resilience performance of the supply chain in times of increasing risks and volatility globally (Al Azmi et al., 2022). Lastly, Liu et al. (2022) emphasize that with the rapid development of big data, cloud computing, blockchain and other financial technologies, it will be important to construct a new supply chain financing model that would promote greater efficiency and innovation in the sector, contributing to the achievement of SDG 9.

The co-occurrence analysis reveals connections between the themes addressed in SDG 10 (Figure 13). SDG 10 aims to reduce inequalities within and among countries and the adoption of blockchain technology and cryptocurrencies have the potential to positively impact this goal. The presence of terms like "inclusion", "protection", "assistance" and "social" in the network, which are directly linked to SDG 10, indicate the relevance of blockchain to reduce inequalities.

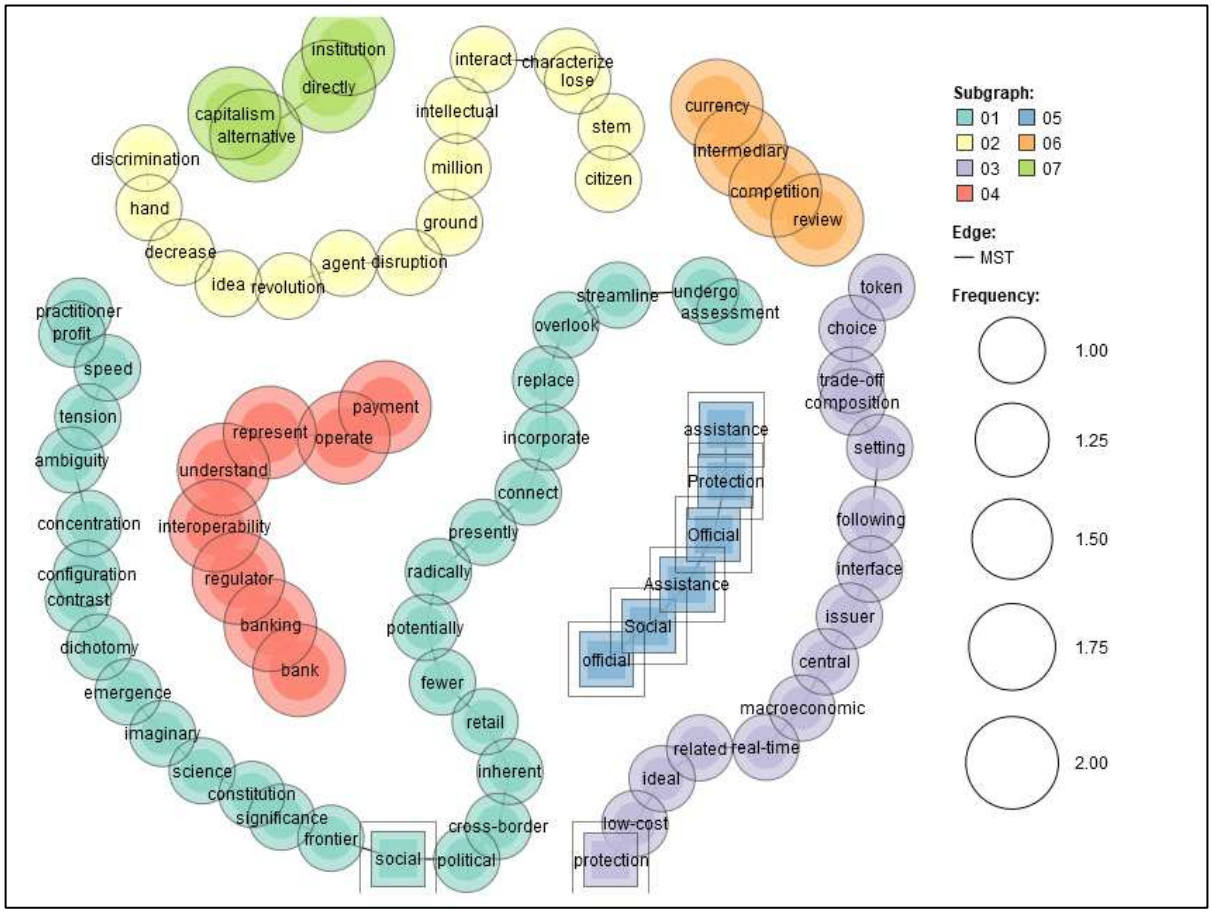


Figure 13: Co-occurrence network of words pertaining to SDG10 (KHCoder).

According to Quayson, Bai and Sarkis (2021), poverty and inequality reduction is an objective of the UN's sustainable development. In this regard, the study exemplifies the precarious subsistence of small farmers within the cocoa supply chain in emerging economies, which is affected by fraudulent activities, exploitation, corruption, child labour, and financial exclusion, thereby contributing to a significant social sustainability issue. It is perceived that

the adoption of digital technologies, such as blockchain, could endorse sustainability and innovate supply chains.

Mangla et al. (2021) considered the social impacts of blockchain technology on farmers, communities, and animals, collating data from a Turkish agricultural development cooperative of dairy producers. Numerous parameters were utilised for the assessment, including rural development, fraud reduction, food market proximity, education, and people promotion. The study established that, over the past 18 years, the cooperative encouraged milk producers within the district to become partners, resulting in an increase in milk production from 30,000 tonnes in 2002 to 330,000 tonnes in 2019.

The co-occurrence network reflects the potentials and challenges linked to blockchain technology and cryptocurrencies in the context of SDG 10. Financial inclusion, social protection, and access to affordable financial services are pertinent aspects in achieving the targets of SDG 10. Scientific literature suggests that blockchain could facilitate financial inclusion and augment the efficiency and transparency of social assistance programmes, whilst cryptocurrencies possess the potential to curtail costs and bureaucracy of international remittances.

On the other hand, terms such as "ambiguity", "regulator" and "interoperability" highlight the challenges to be addressed to ensure that blockchain technology is effectively utilised to accomplish the objectives of SDG 10. Guaranteeing an appropriate regulatory environment and promoting competition among solutions are essential to achieving desired positive impacts. Furthermore, interoperability between systems is a key aspect to integrate efficiently the blockchain-based solutions with existing infrastructures and maximize their potential in inequality reduction.

Figure 14 presents co-occurrences of SDG 17, "Partnerships for the goals". Prominent terms include "partnership", "international", "mobilisation", "capacity", "investment", and "infrastructure", indicating the importance of global alliances, financing, and institutional strengthening in the context of SDG 17. Moreover, terms like "innovation", "transparency", and "efficiency" relate to the role of blockchain technology and cryptocurrencies in promoting innovative solutions, increasing process efficiency, and ensuring information integrity shared among involved partners.

The co-occurrence network also highlights the relevance of "regulatory environment" and "barriers" in implementing blockchain and cryptocurrency-based solutions, suggesting the need for a coordinated approach among the different actors involved, including governments, private sector, and civil society, to overcome challenges and create a conducive environment for the use of these technologies in the service of global sustainable development goals.

The co-occurrence network analysis relative to SDG 17, in conjunction with blockchain technology and cryptocurrencies, emphasises the importance of global partnerships and technological innovation in achieving sustainable development goals. Blockchain technology and cryptocurrencies have the potential to propel efficiency, transparency, and information integrity in the context of international partnerships, resource mobilisation, and capacity building. These emerging technologies can be deployed to overcome barriers and challenges, creating new opportunities for cooperation and financing.

Furthermore, to fully explore the potential of blockchain technology and cryptocurrencies in the context of SDG 17, it is necessary to invest in research, development, and training. Establishing partnerships between different sectors and mobilising financial and human resources are crucial for enabling innovative projects and promoting long-term sustainable solutions. Moreover, maintaining a continuous dialogue among the actors involved is necessary to adapt and refine strategies and approaches, ensuring their suitability to the specific needs and challenges of each context.

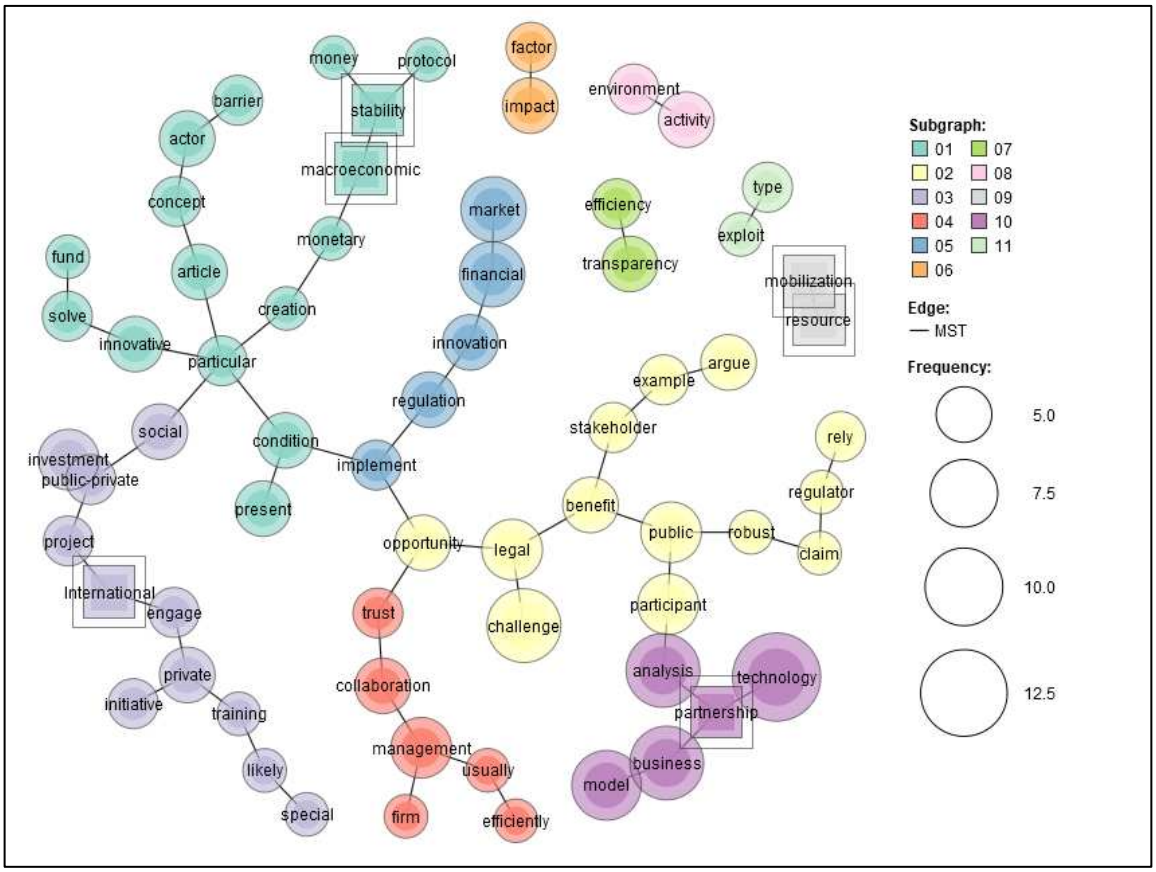


Figure 14: Co-occurrence network of words pertaining to SDG17 (KHCoder).

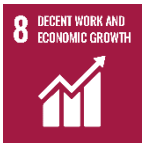
Khatoon (2020) argues that blockchain technology has evolved to become a secure and reliable platform, enabling data sharing in various areas, such as the financial sector, supply chain management, food industry, energy sector, internet of things, and health. In this perspective, Rogerson and Parry (2020) assert that blockchain is part of a system that engenders visibility and trust, providing reliable exchanges and data, and protection against counterfeit products.

According to Nguyen et al. (2019), the rapid development of blockchain technology and its diverse emerging applications have received considerable attention in recent years. This trend is corroborated by the study of Kayikci et al. (2022), asserting that blockchain technology is suitable for tackling major challenges such as traceability, trust, and accountability, not only in the food industry, but also in critical areas, as pointed out by Stoyanova (2020). Recent advancements in hardware and information technology have accelerated the deployment of billions of interconnected, smart, and adaptable devices in critical infrastructures, such as health, transport, environmental control, and home automation.

According to Khatoon et al. (2019), blockchain technology is prepared to transform almost every sector and business model. As an example, the author mentions the energy sector, asserting that energy companies worldwide have already begun to explore the use of blockchain technology in large-scale energy trading systems, peer-to-peer energy trading, project financing, supply chain tracking, and asset management, among other applications.

In summary, SDG 17 underscores the importance of establishing solid partnerships and implementing effective means to promote sustainable development. Blockchain technology emerges as a facilitator in this process, providing transparency, security, and reliability in various sectors and contexts. The increasing adoption and evolution of this technology are likely to strengthen cooperation among the different actors involved, contributing to the achievement of the United Nations' goals and the construction of a more sustainable and equitable future.

Table 5: Potential and challenges of blockchain technology for the attainment of Sustainable Development Goals (SDGs) related to socio-economic matters

SDG	Potentials	Challenges
	Assurance of transparency and security in public resource distribution and assistance in fraud and corruption identification and eradication; Potential to create decentralised microcredit solutions; Enhancement of efficiency and cost reduction in income transfer schemes and other social programmes; Improvement of transparency and security in financial transactions, facilitating financial services accessibility for previously unbanked individuals.	Insufficient regulation and awareness about blockchain; Deficiency of infrastructure and technical knowledge; Regulatory issues; Difficulty of technology access for vulnerable populations; Risks of financial exclusion and socio-economic inequality
	Potential to create decentralised microcredit solutions; Transparency and immutability of information; Traceability and assurance of product origins and combatting of worker exploitation; Assistance in tracing food supply chains and combatting food fraud and adulteration; Improvement of productivity and resilience in the agricultural sector.	Adequate infrastructure. Internet access in rural areas; Deficiency of knowledge and digital skills; Cooperation among different sector actors
	Assurance of medical data security and privacy; Transparency and traceability in patient medical records; Traceability and assurance of drug origins and combat against counterfeiting; Assistance in tracing drug supply chains and fraud combat; Facilitation of interoperability among diverse health institutions.	Patient privacy protection; Assurance of compliance with local laws and regulations; Scalability and capacity to handle the volume of data generated by health systems; Costs and complexity involved in system migration
	Secure and immutable storage of educational records; Facilitation of credential and degree verification; Assurance of teaching and learning quality and reliability; Creation of scholarship financing systems or resource distribution for educational projects; Increase of transparency and efficiency in resource allocation; Inclusion and equity in education.	Technological infrastructure; Knowledge to adopt and use blockchain adequately; Privacy and data security-related issues
	Combatting gender violence; Women's rights protection; Economic equality promotion; Women's inclusion in credit and other financial services. Combatting female worker exploitation	Implementation of solutions to ensure transparency and security in resource distribution for gender equality organisations. Lack of women representation in the tech sector. Overcoming difficulties of access and adoption of this technology by women and girls
	Assistance in tracing supply chains and combatting worker exploitation, contributing to the promotion of sustainable economic growth and decent work; Combatting child labour and forced labour; Recording and tracing of commercial transactions, assisting in combatting illegal commerce and assuring company compliance with labour and environmental laws; Facilitation of financial inclusion; Assurance of transparency and security in public tenders, so contracts are awarded fairly and equitably; Allowing more to benefit from economic growth; Tracing and recording trade of products and raw materials, ensuring ethical and sustainable supply chains	Lack of understanding and widespread acceptance of the technology; Implementing blockchain solutions to record and trace transactions. Regulation and cybersecurity

	Decentralisation, security and transparency; Traceability and assurance of product origins; Fraud combat; Assistance in innovation and development of new projects, promoting construction of resilient infrastructures and inclusive systems; Improvement of process efficiency and traceability; Reduction of intermediary dependency and facilitation of resource and service access; Promotion of financial inclusion.	Scalability, energy consumption, and regulatory issues; Need for adaptation of existing processes and systems; Lack of regulation and awareness about blockchain. Lack of worker representation in the tech sector.
	Contribution to financial inclusion; Improvement of access to financial services; Reduction of transaction costs; Facilitation of efficient and transparent social assistance programmes implementation; Reduction of income inequality and promotion of equity; Decrease in costs and bureaucracy of international remittances; Assistance in combatting global inequalities.	Adequate regulation of cryptocurrencies and blockchain technology; Overcoming of technical and cultural barriers; Assurance of interoperability between different systems and platforms.
	Improvement of transparency and efficiency in resource mobilisation; Facilitation of transaction traceability; Assurance of greater reliability in resource transfer; Enabling the creation of more robust and resilient governance systems; Favouring collaboration among different actors, such as governments, financial institutions, NGOs and the private sector	Lack of standardisation and interoperability among different blockchain-based platforms and systems; Overcoming regulatory and legal barriers; Overcoming issues related to privacy and data security; Establishing a cooperative environment and dialogue among various stakeholders.

Source: Research data.

4. Final Remarks

This paper endeavored to explore the literature concerning cryptocurrencies in the context of Sustainable Finance, primarily focusing on the social and economic facets of the Sustainable Development Goals (SDGs). The employed methodology involved conducting a systematic literature review to analyse the major studies and trends pertinent to this theme. We employed the Methodi Ordinatio methodology to select and categorize relevant scientific articles (Pagani et al., 2017).

The findings revealed the interdisciplinary nature of the blockchain topic, with greater attention in the thematic areas of "Business and Economy," "Computer Science," and "Engineering." Prominent journals manifested keen interest in this subject, as did major publishing houses, while China led in research and project development concerning blockchain, followed by England and the United States.

We executed a Cluster Analysis to distinguish the prime research within the blockchain field. The clusters received the following labels: 1) Agri-food Sector, 2) Digital Money, 3) Strategic Value, 4) Logistics Coordination, 5) Digital Social Innovation for Financial Inclusion, 6) Industry 4.0, and 7) Blockchain Technologies.

Pertaining specifically to cryptocurrencies, Cluster 2, which discussed digital money and finance management, illustrated how blockchain technology can advance financial inclusion and positively affect the lives of millions without access to traditional banking services. This correlates with SDG 1 (Eradication of Poverty), SDG 8 (Decent Work and Economic Growth), and SDG 10 (Reduction of Inequalities). Moreover, the application of blockchain technology in logistics coordination and food supply chains, as discussed by Mangla et al. (2021), contributes towards achieving SDG 9 (Industry, Innovation and Infrastructure) and SDG 12 (Responsible Consumption and Production).

Furthermore, blockchain, as a digital social innovation, holds potential to promote financial inclusion and contribute to the SDGs, as highlighted by Farnoush et al. (2022), Quayson, Bai, & Sarkis (2021), and Prasad, Shankar, Gupta, & Roy (2018). By overcoming

barriers and empowering less privileged populations, blockchain technology can improve sustainability and inclusion, aligning with SDGs 1 and 9, among others.

The examination of the alignment of the articles to the SDGs revealed that SDG 9 and SDG 17 resonate most with the research in the area of blockchain and cryptocurrencies. Additionally, keyword co-occurrence analysis revealed the primary themes discussed in the studies, such as blockchain technology, technology, Bitcoin, management, internet, challenges, and system. These findings can enhance our understanding of the current landscape and future trends in the field of study, assisting researchers and professionals in devising strategies to address emerging challenges and opportunities.

The findings showed that the literature concerning cryptocurrencies and Sustainable Finance is nascent yet growing. A convergence between cryptocurrencies and the SDGs was identifiable, especially regarding financial inclusion, economic stability, innovation, and infrastructure. Furthermore, it was observed that cryptocurrencies could contribute to the democratisation of access to financial services and foster a more balanced distribution of resources, acting as a catalyst for sustainable development.

However, this study also identified several challenges and limitations relating to the adoption of cryptocurrencies within the context of Sustainable Finance. Price volatility, lack of regulation, environmental concerns, and risks associated with security and privacy are among the obstacles that require attention. This study contributes to the literature by providing an overview of the current state of research on cryptocurrencies and sustainable finance. It also underscores the importance of considering cryptocurrencies from the perspective of the SDGs and identifies possible paths for integrating these technologies into the context of sustainable finance.

For future studies, it is recommended to delve deeper into the relationships between cryptocurrencies and the SDGs, examining the implications of emerging technologies such as stablecoins and asset tokenisation within the sustainable finance context. Moreover, the role of public policies and regulatory bodies in promoting the sustainable and inclusive adoption of cryptocurrencies is worth exploring. Lastly, empirical studies assessing the impact of cryptocurrencies on achieving the SDGs across various contexts and regions are a crucial direction for future research. Blockchain technology holds significant potential to contribute to the achievement of the SDGs by promoting innovation, efficiency, and sustainability in various sectors, such as Finance, supply chains, industry, and agri-food. By adopting this technology and empowering less privileged populations, it is possible to move towards a more inclusive and sustainable future.

References

Azmi, N. A., Sweis, G., Sweis, R., & Sammour, F. (2022). Exploring Implementation of Blockchain for the Supply Chain Resilience and Sustainability of the Construction Industry in Saudi Arabia. *Sustainability,* 14(11), 6427. https://doi.org/10.3390/su14116427

Boninsegni, M. F., Roy, A., Bakpayev, M., Kumar, S., Peronard, J.-P., & Reimer, T. (2022). Opportunities of and threats to consumer well-being in the age of Fourth Industrial Revolution (IR 4.0) technologies. Digital Policy, Regulation and Governance, 24(1), 93–105. https://doi.org/10.1108/DPRG-06-2021-0080

Chen, W., Botchie, D., Braganza, A., & Han, H. (2022). A transaction cost perspective on blockchain governance in global value chains. *Strategic Change*, *31*(1), 75–87. https://doi.org/10.1002/jsc.2487

Farnoush, A., Gupta, A., Dolarsara, H. A., Paradice, D., & Rao, S. (2022). Going beyond intent to adopt Blockchain: an analytics approach to understand board member and financial health characteristics. *Annals of Operations Research*, *308*(1–2), 93–123. https://doi.org/10.1007/s10479-021-04113-0

Hew, J.-J., Wong, L.-W., Tan, G. W.-H., Ooi, K.-B., & Lin, B. (2020). The blockchain-based Halal traceability systems: a hype or reality? *Supply Chain Management: An International Journal,* 25(6), 863–879. https://doi.org/10.1108/SCM-01-2020-0044

Higuchi, K. (2016, March). *Kh coder 3 reference manual.* Retrieved 2021-06-27, from https://khcoder.net/en/manual_en_v3.pdf

Kayikci, Y., Subramanian, N., Dora, M., & Bhatia, M. S. (2022). Food supply chain in the era of Industry 4.0: blockchain technology implementation opportunities and impediments from the perspective of people, process, performance, and technology. *Production Planning & Control*, *33*(2–3), 301–321. https://doi.org/10.1080/09537287.2020.1810757

Khan, N., Kchouri, B., Yatoo, N. A., Kräussl, Z., Patel, A., & State, R. (2022). Tokenization of sukuk: Ethereum case study. *Global Finance Journal,* 51, 100539. https://doi.org/10.1016/j.gfj.2020.100539

Khatoon, A. (2020). A Blockchain-Based Smart Contract System for Healthcare Management. *Electronics*, *9*(1), 94. https://doi.org/10.3390/electronics9010094

Kim, J.-S., & Shin, N. (2019). The Impact of Blockchain Technology Application on Supply Chain Partnership and Performance. *Sustainability*, *11*(21), 6181. https://doi.org/10.3390/su11216181

Kshetri, N. (2017). Blockchain's roles in strengthening cybersecurity and protecting privacy. *Telecommunications Policy*, *41*(10), 1027–1038. https://doi.org/10.1016/j.telpol.2017.09.003

Mangla, S. K., Kazancoglu, Y., Ekinci, E., Liu, M., Özbiltekin, M., & Sezer, M. D. (2021). Using system dynamics to analyze the societal impacts of blockchain technology in milk supply chainsrefer. *Transportation Research Part E: Logistics and Transportation Review*, *149*, 102289. https://doi.org/10.1016/j.tre.2021.102289

Medeiros, I. L. de, Vieira, A., Braviano, G., & Gonçalves, B. S. (2015). Revisão Sistemática e Bibliometria facilitadas por um Canvas para visualização de informação. *InfoDesign - Revista Brasileira De Design Da Informação*, 12 (1), 93–110.

McGregor, Nicholas. (2021, maio 26). Os planos ambiciosos da Cardano para a África. Recuperado 6 de dezembro de 2022, de Yahoo Finanças website: https://br.financas.yahoo.com/noticias/os-planos-ambiciosos-da-cardano-121300223.html

Mosteanu, N. R., & Faccia, A. (2020). Digital Systems and New Challenges of Financial Management – FinTech, XBRL, Blockchain and Cryptocurrencies. *Quality – Access to Success*, 21(174), 159-166.

Nguyen, C. T., Hoang, D. T., Nguyen, D. N., Niyato, D., Nguyen, H. T., & Dutkiewicz, E. (2019). Proof-of-Stake Consensus Mechanisms for Future Blockchain Networks: Fundamentals, Applications and Opportunities. *IEEE Access*, *7*, 85727–85745. https://doi.org/10.1109/ACCESS.2019.2925010

Okoli, C., Duarte, T. por:David W. A., & Mattar, R. técnica e introdução: João. (2019). Guia Para Realizar uma Revisão Sistemática de Lteratura. *EAD em Foco*, *9*(1). doi: 10.18264/eadf.v9i1.748

Pagani, R. N., Kovaleski, J. L., & Resende, L. M. M. de. (2017). Avanços na composição da Methodi Ordinatio para revisão sistemática de literatura. *Ci.Inf.*, *46*, 161–187.

Parmentola, A., Petrillo, A., Tutore, I., & De Felice, F. (2022). Is blockchain able to enhance environmental sustainability? A systematic review and research agenda from the perspective of Sustainable Development Goals (SDGs). *Business Strategy and the Environment*, *31*(1), 194–217. doi: 10.1002/bse.2882

Prasad, S., Shankar, R., Gupta, R., & Roy, S. (2018). A TISM modeling of critical success factors of blockchain based cloud services. *Journal of Advances in Management Research,* 15(4), 434–456. https://doi.org/10.1108/JAMR-03-2018-0027

Quayson, M., Bai, C., & Sarkis, J. (2021). Technology for Social Good Foundations: A Perspective From the Smallholder Farmer in Sustainable Supply Chains. *IEEE Transactions on Engineering Management,* 68(3), 894–898. https://doi.org/10.1109/TEM.2020.2996003

Rajnak, V., & Puschmann, T. (2021). The impact of blockchain on business models in banking. *Information Systems and E-Business Management*, 19(3), 809–861. https://doi.org/10.1007/s10257-020-00468-2

Rogerson, M., & Parry, G. C. (2020). Blockchain: case studies in food supply chain visibility. *Supply Chain Management: An International Journal,* 25(5), 601–614. https://doi.org/10.1108/SCM-08-2019-0300

Stoyanova, M., Nikoloudakis, Y., Panagiotakis, S., Pallis, E., & Markakis, E. K. (2020). A Survey on the Internet of Things (IoT) Forensics: Challenges, Approaches, and Open Issues. *IEEE Communications Surveys And Tutorials*, *22*(2), 1191–1221. https://doi.org/10.1109/COMST.2019.2962586

Teng, S. Y., Touš, M., Leong, W. D., How, B. S., Lam, H. L., & Máša, V. (2021). Recent advances on industrial data-driven energy savings: Digital twins and infrastructures. *Renewable and Sustainable Energy Reviews,* 135, 110208. https://doi.org/10.1016/j.rser.2020.110208

Zhao, G., Liu, S., Lopez, C., Lu, H., Elgueta, S., Chen, H., & Boshkoska, B. M. (2019). Blockchain technology in agri-food value chain management: A synthesis of applications, challenges and future research directions. *Computers in Industry*, *109*, 83–99. https://doi.org/10.1016/j.compind.2019.04.002