BIBLIOMETRIC ANALYSIS OF SMART CONTRACTS IN BLOCKCHAIN TECHNOLOGY

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Abstract

In an era of rising digitalization, terms focused on blockchain, smart contracts, and artificial intelligence are becoming increasingly prominent both theoretically and practically in financial markets and implicitly in the performance of businesses. Considered the second blockchain in the world, smart contracts are designed to automate the agreement between the contract creator and recipient in a time-efficient manner for both participants. The purpose of this article is to present the benefits of using smart contracts in blockchain applications. The research methodology will thus involve a qualitative analysis of specialized publications, specifically a review that examines the effects of using smart contracts from 2015 to 2024. The results obtained from the research illustrate the benefits generated by using this type of blockchain and build support for professionals as well as for companies.

Keywords

smart contract, blockchain, digitization, bibliometric analysis, descentralized application

JEL Classification

D86, O30, M00

Introduction

Blockchain technology has stood out over the years, positioning itself as a subject of great interest and impact in the field of scientific research, as well as in the practice of companies, proposing ideas and solutions characterized by digitalization, novelty, innovation, shaping a true success in increasing the degree of security, transparency and decentralization.

As an integral part of blockchain technology, one of the most remarkable applications is called smart contracts. This type of contract is characterized by a self-executing program that, when activated by two or more users- specifically the creator of the contract and the recipients- enables the safe and automatic execution of digital

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agreements without requiring a third party or trusted intermediary to finalize the contract, as is done in traditional contracts in physical form.

Thus, the definition of a smart contract can be viewed as a convention expressed through program code implemented on the blockchain platform, which enhances the efficiency, autonomy, and interdependence of agreements based on specific conventional factors among beneficiary users of smart contracts.

The concept of smart contracts dates back many years, when Nick Szabo introduced the term in 1997. However, it was only brought to the public's attention in 2015 with the emergence of Ethereum, a platform that enables the implementation of smart contracts (Buterin, 2014).

Considering that technological evolution is in full swing, and smart contracts have expanded their functionality, currently, companies, but also individual users, can access such contracts using a wide range of applications, in a multitude of industries, starting from legal and economic services, reaching health services, digital governance and outsourced trade (Casino et al., 2019).

Like any new type of technology based on digitalization and innovation, there are a series of challenges related to security, scalability, and legislative regulations (Luu et al., 2016).

Building on the aforementioned points and the existing evidence concerning the exponential growth of access and research related to blockchain technology and smart contracts, this article aims to conduct a bibliometric analysis of significant scientific publications. This analysis will illustrate the evolutionary dynamics of this field of interest, focusing on the reference period from 2015 to 2024. We will examine the most prominent authors, the number of publications, their impact on information users, and future research trends, utilizing the Web of Science as a data collection source.

The objectives pursued by the article are to identify the volume and distribution over time of published scientific papers on smart contracts through blockchain technology, to determine the authors and institutions with the highest degree of impact in this sector and, subsequently, to map the areas of applicability of these types of contracts and the future directions proposed for approach.

Through this bibliometric analysis, we aim to obtain relevant and valuable results to enhance understanding of the dynamics of research on blockchain technology and the concept of smart contracts. At the same time, the analysis results will provide a clear picture of the challenges and opportunities available for the broad implementation of smart contracts.

Next, aspects regarding the theoretical side proposed by researchers who have addressed smart contracts and blockchain technology will be highlighted, followed by the applied side presented in the methodology and research results section, building with the help of the Vosviewer program a bibliometric analysis on the subject addressed to illustrate an evolutionary picture of the approach to these notions, as well as to predict the future impact of smart contracts in blockchain. The end of the article will be reserved for the conclusions and discussions section.

1. Review of the scientific literature

Specialised publications offer an image that reflects a significant expansion of the research approach to smart contracts from 2015 to the present.

Blockchain technology is decentralized, offering key benefits such as transparency, immutability, and security for both users and companies integrating it into their activities (Nakamoto, 2008). It is defined as an "open, distributed ledger that can record transactions between two parties efficiently, verifiably, and permanently" (Iansiti & Lakhani, 2017).

Starting from the mentions illustrated by these researchers, the idea can be illustrated according to which smart contracts are programs that have the possibility of self-execution by running them on various blockchain-based applications and that can be concluded quickly and securely, without the need for the intervention of a third actor characterized in most cases by an intermediary (Szabo, 1997).

With the launch of the first blockchain-based platform and operating system, Ethereum, fundamental studies on smart contracts and their applicability at a global level also emerged (Buterin, 2014).

Wood (2015) specified essential aspects regarding the correct execution of smart contracts through the proposals of the Ethereum platform.

Luu et al. (2016) highlighted, in their publication, the problems that may arise regarding the security of the use of smart contracts, unpleasant situations that may materialize through Decentralized Autonomous Organization (DAO) type attacks (the second largest crypto attack in history), which had a disastrous impact, the loss of millions of dollars.

Another detailed research on the challenges of blockchain technology and smart contracts was conducted in 2017, illustrating aspects that were surprising regarding the scalability and energy consumption involved in this era of digitized contracts (Zheng et al., 2017).

The applicability of smart contracts is impressive, with their implementation covering sectors such as health, finance, international trade and even the public sector:

- ✓ Finance:

According to Harvey et al. (2021), the impact of smart contracts on DeFi ecosystems, which involve an emerging decentralized peer-to-peer finance utilising blockchain technology and cryptocurrencies, allowing companies and individuals to transact directly with each other, is considerable and favourable.

At the same time, Zhang et al. (2022) highlight the principal vulnerabilities that smart contracts face in the financial system, including the difficulty of concretely identifying non-optimal contract functioning, scalability issues over time, and flash attacks (cybersecurity threats).

- ✓ Health system:

Kumar et al. (2020) identified the use of blockchain as a promising application in the healthcare sector, bringing benefits and streamlining actions in identity management, dynamic patient consent, and supply chains for medical consumables and pharmaceuticals. Emerging technologies have also contributed to streamlining the study, diagnosis, and treatment of patients suffering from COVID-19.

Saha et al. (2022) also emphasize the high security and protection of patient data in the event of hospitalization or presentation to healthcare institutions, utilizing blockchain technology.

- ✓ International trade

Holland et al. (2021) emphasize that the results obtained from the analysis indicate the potential for smart contracts to contribute to the reduction of fraudulent operations and delays in international transport.

- ✓ Public sector

Hughes et al. (2019) stand out in the specialised literature for their proposal to improve and enhance electoral transparency, specifically by introducing an electronic voting model based on smart contracts. The accessibility and transparency of electronic voting would significantly help eliminate potential fraud during elections.

The specialized literature cites scientific works that highlight the challenges of smart contracts in terms of security and code reliability.

Siegel (2016) highlights, through the DAO attack of 2016, the critical vulnerabilities that smart contracts have, proposing to solve them by dividing the blockchain into Ethereum and Ethereum Classic.

Destefanis et al. (2018) illustrate and propose as a means of standardization and verification the introduction of audit tools designed to achieve the security of smart contract code, and Bhargavan et al. (2016) provide, following technical research, formal verifications, through a model based on symbolic processing and static analysis, which can represent an essential step to be carried out before implementing smart contracts, thus contributing to the identification of potential vulnerabilities and the avoidance of severe attacks (such as the DAO case, in which over 50 million dollars were lost). This formal verification stage is intended to eliminate possible critical errors that the programming languages in which smart contracts are written may have.

Regarding the part of specialised publications that involve performing a bibliometric analysis, the analysis of specialized literature mentions Xu et al. (2019), in which the researchers concluded that publications in the field of blockchain technology and smart contracts have increased significantly in recent years. Sun et al. (2021) utilise the VOSviewer application to capture the publications and authors with the most significant influence and impact on users of information on smart contracts. Chen et al. (2023) conducted an analysis using the CiteSpace application, which highlighted international collaborations in the fields of smart contracts and blockchain.

Wang et al. (2023) specify the need for smart contracts to function on multiple types of networks, this assuming interoperability of blockchains.

At the same time, Giancaspro (2017) describes the legal challenge of smart contracts as their global legal recognition, thereby eliminating the regulatory disadvantage of using contracts.

Thus, early studies, such as those by Wood (2015) and Luu et al. (2016), primarily capture information focusing on the technical and security aspects of smart contracts. More recent research, however, highlights the application side more by providing results obtained through practical analyses of contracts and their applicability in fields such as law, health and international trade (Zheng et al., 2020).

The most relevant and interesting analysis, conducted between 2020 and 2023, is the one based on bibliometrics, which served as the basis for writing this article and informed the bibliometric analysis proposed within it, starting from the previously analysed ideas, as illustrated in the research methodology.

2. Research methodology

The bibliometric study, building on the previously illustrated research, was conducted using the years 2015-2024 as the reference period. Its primary purpose is to identify trends in the writing and publication of articles addressing the subject of smart contracts. Additionally, through bibliometric analysis, the dominant countries and journals contributing to this topic will be identified, as well as the impact these publications have on users of scientific information in the academic environment.

A series of research questions was constructed:

1. What is the evolution, over the period 2015-2024, of specialized publications regarding the approach to smart contracts in blockchain technology?
2. Which geographic regions are making the greatest contribution to the expansion of the smart contract literature?
3. Who are the most relevant authors in the field of smart contract analysis?
4. What research topics and trends regarding smart contracts in blockchain are most often addressed?

Starting from these four questions, the research hypotheses were built, which we will verify in the next part of the paper, more precisely in the section that focuses on the research results:

H1: The number of specialized works addressing the integration of smart contracts through blockchain technologies increased between 2015-2024, with an increase observed after 2017 through the integration of DeFi platforms;

H2: International collaboration in analysing smart contracts is expanding, especially in North America, Western Europe, and East Asia.

H3: The research core is concentrated, the specialised literature being dominated by a small number of authors.

H4: The main research topics focus on security and decentralised accounting (DeFi) of smart contracts and blockchain.

Based on the dataset created using the Web of Science website, which started with the keywords "smart contract," "blockchain," and "decentralized accounting," a bibliometric analysis was conducted, resulting in an initial sample of 49,298 specialized publications. In terms of the criteria applied in refining the dataset, open access publications were selected, which addressed elements in correlation with the subject of smart contracts and blockchain technology (19,360 articles), the reference period 2015-2024 (18,906 articles), indexed article publications were selected (14,235 articles), and the research area: “management”, “business”, “economics”, “business finance”, “Medicine Research Experimental” (1,498 articles), and the preserved works were only in English. The exclusion criteria targeted duplicate scientific works and those irrelevant to the analysis's objective, as well as review-type works, ultimately resulting in a total of 1,457 articles. The tool used to evaluate collaboration networks and co-citations is the

VOSviewer application, and the processing of the obtained data was carried out through its specific options.

3. Results and discussions

Starting from the first research hypothesis, we analysed chronological trends in scientific publications, and as shown in Figure No. 1, there is a consistent increase in the number of specialised articles addressing the topic of smart contracts in blockchain technology. It is noted that during the analysed period, the importance given to this topic by researchers increased, with 2023 being the year that saw the highest number of articles proposed to information users. This significant evolution outlines the academic progress and practical application of new technologies, as well as the intense dynamics of scientific analysis in interconnected fields.

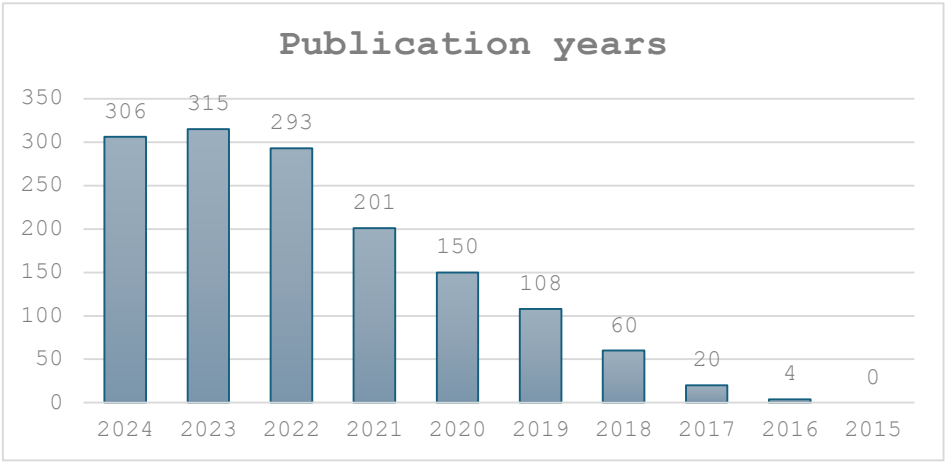

Figure no. 1 Distribution of the number of articles published between 2015-2024

Source: Own Excel processing basen on Sheela et. al. (2023)

It can be seen that the first research hypothesis (H1) is accepted, and the number of specialised publications on smart contracts in blockchain technology has increased considerably since 2017.

Regarding the geographical distribution of scientific publications, as shown in Figure No. 2, the density of appearances in each region is observed, with the highest number of articles recorded in England, specifically 303 articles addressing the subject of smart contracts. A significant number of articles are also registered in the USA, followed by Germany and Italy. The fewest publications are recorded in Scotland, which highlights the low interest in the implications of blockchain technology until 2024. The graph aims to highlight the interest and importance that each region attributes to addressing the subject of this paper.

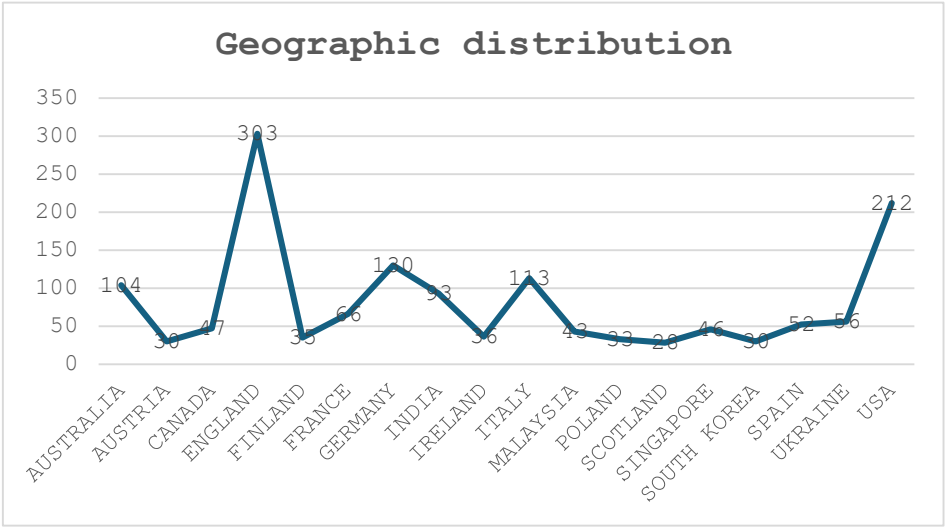

Figure no. 2 Geographic distribution of published articles
Source: Own Excel processing basen on Hurducaci & Ionescu (2024)

The second hypothesis is also validated, noting from the above representation that the significant regions publishing articles addressing the subject of smart contracts are concentrated in North America, Western Europe and East Asia.
At the same time, according to Table no. 1, the ranking is led by the author Treiblmaier, Horst with the most specialized publications (9) and the highest number of citations (643), standing out with an important influence and relevance in terms of his writings, followed by Schwabe, Gerhard with nine articles, but with several only 233 citations and Corbet, Shaen with eight publications and 302 citations. According to the data provided in the table below, the dynamics of publications and academic influence among the scientific community focused on the topic of smart contracts in blockchain are remarkable.
The third hypothesis is also accepted, the number of authors not being relevantly large, the research core being concentrated.

Table no. 1 The principal authors of the publications

Author	Publications	Citations
schwabe, gerhard	9	233
treiblmaier, horst	9	643
corbet, shaen	8	302
urbach, nils	8	178
upadhyay, nitin	6	4
zavolokina, liudmila	5	121
fridgen, gilbert	5	127
lucey, brian	5	189
allen, darcy w.e.	5	43
kumar, anil	5	150

Source: Own Excel processing basen on Sheela et. al. (2023)

For the analysis of the fourth research hypothesis, with the help of the VOSviewer program, we have created a series of figures illustrating a network of term co-occurrence, which will contribute to highlighting the main research themes related to smart contracts in blockchain technology and the existing relationships between key concepts and emerging trends.

Starting from the information illustrated in Figure 3, obtained after processing data from Web of Science through the VOSviewer program, 165 items were grouped into 10 categories for the period 2015-2024. This result was general after eliminating irrelevant words, leaving the associations identified between the keywords (blockchain, smart contract and decentralized accounting).

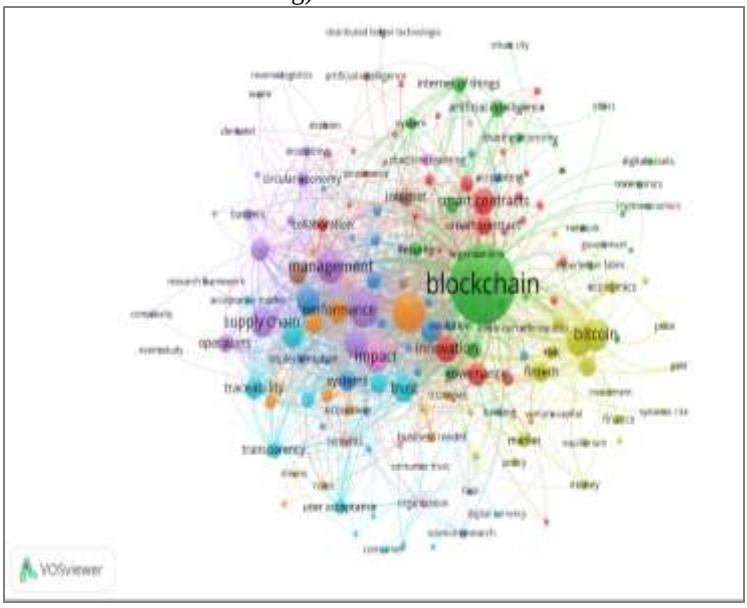

Figure no. 3 Network visualization on smart contract in blockchain

Source: Processing in VOSviewer basen on Bellucci, Cesa Bianchi & Manetti, (2022)

The primary term and keyword used in the analysis centers on blockchain. It is observed that this notion forms the largest node in the analysis, representing its core. In addition to blockchain, another keyword introduced during the collection and processing of the Web of Science dataset, which is seen to be strongly connected, pertains to smart contracts, highlighting the role of this technological innovation in the blockchain era, with an interdependence between the two concepts.

Additionally, Figure 3 shows that the importance and applicability of smart contracts in blockchain technology are distributed across various sectors, with the most prominent including innovation, performance, supply chain, governance, trust, and fintech, as illustrated in different clusters.

By carefully analysing the links concentrated around the blockchain core, as shown in Figure 4, different thematic groupings can be identified, distinctly highlighted by different colours.

The technological and financial cluster, illustrated in green, represents the integration of blockchain technology through smart contracts in cryptocurrencies, supporting the theoretical arguments presented in the specialized works referenced in the literature section. Most terms that highlight this aspect relate to Bitcoin, digital assets, cryptocurrency economics, finance, investment, or tokenomics.

The purple cluster, concentrated around management terms, highlights connectivity, operations, supply chain or complexity.

The red cluster illustrates, through the link between the keyword and terms such as artificial intelligence, internet of things, machine learning, smart city and ethics, the innovative character and the convergence trend between these sectors.

Another representative cluster for the analysis is the one targeting governance and the political plan, highlighted by the blue shade, and encompassing terms such as governance, policy, business model, or market, which outline the effect of integrating blockchain technology within regulations.

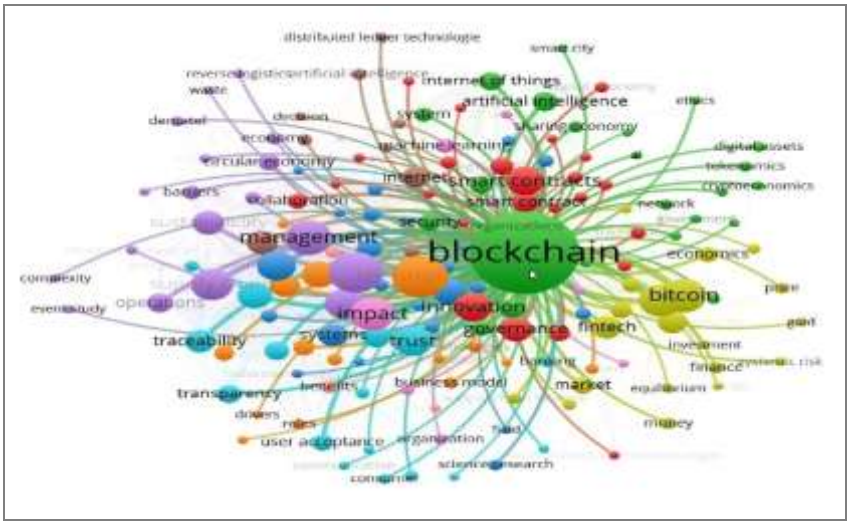

Figure no. 4. Representation of blockchain term

Source: Processing in VOSviewer basen on Bellucci, Cesa Bianchi & Manetti, (2022)

It can thus be seen that there are clear trends focusing attention in various fields on smart contracts and blockchain technology, with a growing trend in the area of digital economy and decentralized accounting, a fact highlighted by the yellow cluster and further explored in Figure no. 5, which leads to the acceptance of the fourth hypothesis.

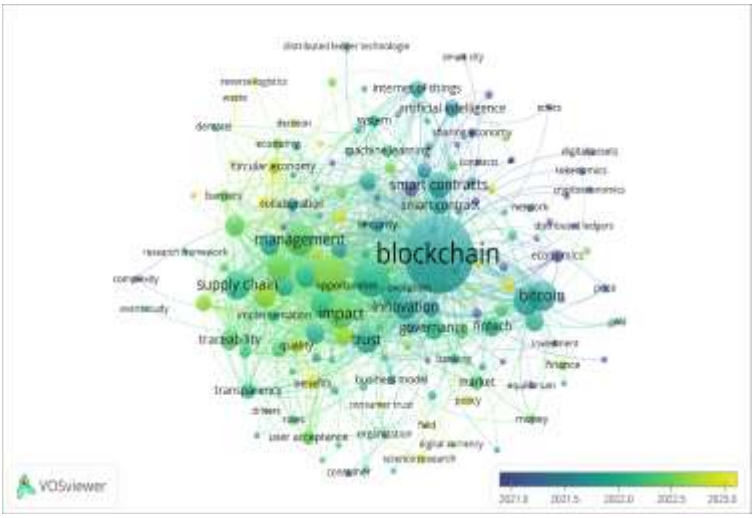

Figure no. 5 The evolution of blockchain technology over time

Source: Processing in VOSviewer basen on Bellucci, Cesa Bianchi & Manetti, (2022)

As can be seen in the figure above, there is a time scale related to the evolution, during the period 2021-2023, of the terms that come into contact with blockchain. Between 2015 and 2024, we had 8,602 links between keywords and terms from various domains. In the period 2021-2023, 3,055 links were identified after extracting irrelevant words, and 165 items were grouped into 10 clusters. The current trending terms focus on digital assets and cryptocurrency economics, illustrating an intense academic and scientific interest in the connection between blockchain and economic aspects.

The blue area provides terms used in older periods, including notions such as trust, transparency, and impact, which are relevant to research topics.

The evolutionary transition of research over time, from fundamental themes of security and trust to economic applications and the integration of blockchain technology, smart contracts, and artificial intelligence, highlights the growing interest in this scientific approach, which is in continuous expansion, addressing new emerging themes oriented towards takenomics and crypto-economics.

Figure no. 5 also constitutes a starting point for future research perspectives on the use and integration of smart contracts in the blockchain technology of companies.

Focusing on the connection of the term' smart contracts' with other sectors of activity, as shown in Figure 6, it can be seen that the subject of smart contracts is an interdisciplinary one, with applicability that spans a wide range of fields in economics, management, security, and new technologies. The strong connection between smart contract nodes and the blockchain is highlighted, with the node illustrated in red requiring the green node to function.

Strong connections are also confirmed between smart contracts and subjects such as the internet, artificial intelligence, and security, demonstrating that automation, the introduction of artificial intelligence technologies into activities, and approaches to security issues are of high interest in scientific research.

The technological and automation cluster, visible in red, illustrates the trend of integrating smart contracts with new digital innovations in artificial intelligence, opening up new perspectives for process automation and decision-making.

The financial connection illustrated in the yellow network highlights the critical role of smart contracts in the decentralized economy, along with the main challenges posed by potential financial risks and relevant legal regulations.

The blue network illustrates the decision-making transparency that can contribute as an advantage by integrating smart contracts into the activity carried out, and through terms such as: management, traceability and sustainability, positioned within the purple network, the favorable impact of these types of contracts for the automation and security of logistics chains is outlined.

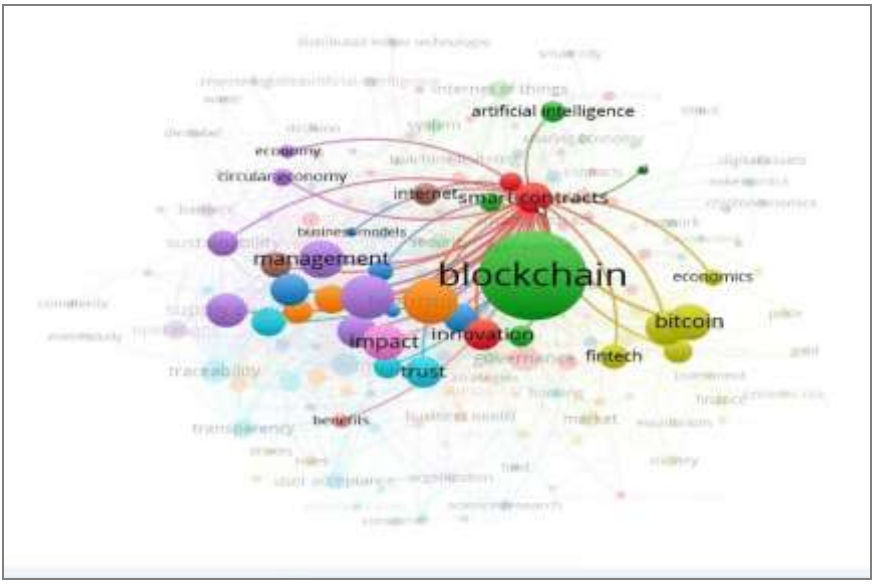

Figure no. 6 Representation of smart contract terms
Source: Processing in VOSviewer basen on Bellucci, Cesa Bianchi & Manetti, (2022)

It can be seen, therefore, that the main element of blockchain technology is smart contracts, with extensive applicability in the fields of finance, governance, security, and digitalization, becoming key elements of future research.
The bibliometric analysis reveals numerous connections between blockchain technology, smart contracts, decentralised accounting, and various sectors. There is also a growing trend among many regions and authors to discuss smart contracts in specialised publications, highlighting their utility and significant impact in both the academic world and practical applications.
Based on these conclusions, we also created a linear projection of future publications, utilising historical publication trends and key influencing factors as representative elements.
Hypothesis: There is a significant positive relationship between the calendar year and the number of scientific publications from 2016 to 2024, suggesting that the year is a relevant predictor for estimating the evolution of scientific output.
A simple linear regression model was used to identify a temporal trend in the evolution of scientific publications from 2016 to 2024, with the year as the independent variable and the number of publications as the dependent variable, with Excel.

Table no. 2 Regression Statistics

Multiple R	0.982550243
R Square	0.96540498
Adjusted R Square	0.960462834

Standard Error	24.49632302
Observations	9

Source: Own Excel processing

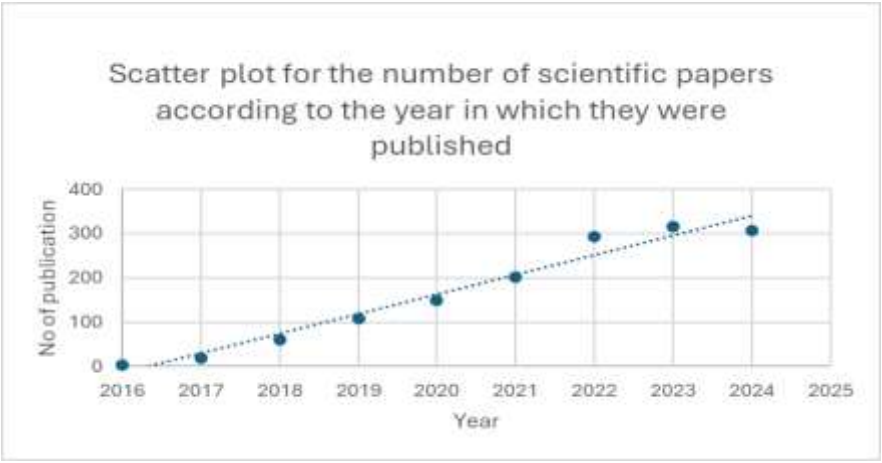

Figure no. 7 Scatter diagram of the number of scientific publications
Source: Own Excel processing basen on Hurducaci & Ionescu (2024)

The estimated model has the following form: Publications = Publications t = 44.2 x $Year_t$ – 89,120.

Table no. 3 regression results

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	-89122.11111	6388.177858	-13.95110047	2.30016E-06
X Variable 1	44.2	3.162461703	13.97645384	2.272E-06

Source: Own Excel processing

The regression results indicate a statistically significant positive relationship between the year and the number of publications, with a coefficient for the "Year" variable of $\beta = 44.2$. This suggests that the number of publications increases on average by approximately 44.2 papers per year.

The model's explanatory power is very high, with the coefficient of determination being: $R^2 = 0.965$. This indicates that 96.5% of the variance in the number of publications is explained by the linear model, demonstrating an excellent fit of the data to the model.

An analysis of variance (ANOVA) was performed to assess the model's overall significance. The F-test results are as follows:

Table no. 4 Analysis of variance (ANOVA)

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	117218.4	117218.4	195.3412619	2.272E-06
Residual	7	4200.488889	600.0698413		
Total	8	121418.8889			

Source: Own Excel processing

This result, **F(1,7) = 195.34**, **p < 0.001 (p = 2.27e-06),** confirms that the model is statistically significant, meaning that there is a linear relationship between the calendar year and the number of scientific publications.

Simple linear regression indicates a clear upward trend in the number of scientific publications during the analysed period. Given the high R^2 value and the significant F-test result, it can be concluded that the year serves as a robust predictor for estimating the number of publications. However, the slight decline observed in 2024 suggests that further analysis using nonlinear models could offer a more comprehensive understanding of long-term evolution.

Thus, using a forecast function to illustrate potential directions for future research, the regression equation for the estimated (anticipated) increase in the number of publications for the period 2025-2030 is the following:

$$R_{t+5}=R_t\times (1+g)^5$$

$$R_{2030}=1{,}115 \times (1.10)^5 = 1{,}115\times 1.6105 = 1{,}796 \text{ publications}$$

According to the equation, Rt represents the anticipated number of publications at time t, and the independent variables reflect the primary factors that contribute to research growth.

We used an estimated annual rate (g) of 10%, and by applying it to the number of publications found in the period 2021-2024 according to the data illustrated in Figure no. 1, the idea is that approximately 1,796 scientific papers are expected to be registered by 2030.

The absolute difference between the two estimates is 1,191.83 publications, representing a relative difference of 66.37% compared to the estimate generated by the empirical formula.

This significant discrepancy can be explained by the fundamentally different nature of the two models:

The linear regression model assumes a constant (additive) increase over time, based on the observed historical trend. Although it provides an excellent fit for the analysed period ($R^2 = 0.965$), it does not capture the potentially exponential nature of scientific research development in a dynamic context, influenced by factors such as accelerated digitalisation, increased funding, or international collaborations.

On the other hand, the empirical formula reflects geometric (exponential) growth and is more appropriate in contexts where an accelerated accumulation of knowledge and scientific output is anticipated. However, it is highly sensitive to the assumed growth

rate and does not account for potential plateaus or external shocks (e.g., pandemics, policy changes). s in research funding).

In conclusion, the linear regression model provides a conservative, data-driven estimate based on concrete historical trends and is particularly useful for short- to medium-term forecasting. Although the empirical formula is more optimistic, it assumes an idealised growth dynamic. Therefore, using both methods in parallel can offer a realistic uncertainty band, outlining a plausible interval for the expected evolution of scientific publication output by 2030. Thus, the results obtained highlight the growing academic interest in smart contracts within blockchain technology.

The results of a bibliometric analysis of smart contracts in blockchain technology highlight a significant academic interest in addressing this topic, as demonstrated by the substantial evolution of works published between 2015 and 2024. As previously stated, taking into account that hypothesis 1 was accepted due to the increase, starting with 2017, in the number of specialised publications, a maturation of blockchain technology and the introduction of new functional ecosystems, such as Ethereum, which led to extensive testing of smart contracts, is observed.

It is observed that the works with a high degree of influence focus on security and scalability, thus highlighting a series of technological challenges that prevent the intensive introduction of smart contracts on a large scale.

At the same time, a shift from theoretical to practical topics is observed, as indicated by the analysis of keywords used, such as decentralized finance, smart contracts for managing supply chains, and implementing contracts in digital governance systems, researchers' interest is focused on decentralized accounting applications, such as DeFi, results that contribute to the validation of the fourth hypothesis, demonstrating that the specialized literature is continuously expanding towards practical applicability regarding smart contracts.

The third confirmed hypothesis illustrates a concentrated core of specialists, having a strong impact on the development of specialized literature, but also on the practical side of smart contracts. Thus, it is noteworthy that the approach to topics related to smart contracts and blockchain technology is fueled both by academic interest and by the identification of practical and efficient ideas necessary for their applicability.

The geographical distribution illustrated in Figure no. 2 highlights the origin of publications in highly developed regions, thus highlighting the need to involve authors from emerging economies to contribute to the wide-scale expansion of the introduction of smart contracts and blockchain. The co-authorship network also illustrates a series of strong links between researchers from East Asia (China), Western Europe (Germany, UK) and North America, suggesting the global interest that smart contracts have on researchers and practitioners.

Starting from the findings presented, a series of theoretical and practical implications are observed. Regarding the theoretical section, the findings help to consolidate an efficient conceptual framework for approaching the notion of smart contracts. Aspects regarding dominant themes and future research projections are highlighted, aiming at the integration of artificial intelligence into smart contracts, the standardisation of blockchain technology, or aspects regarding legal regulations. In terms of practical applicability, the bibliometric analysis of smart contracts in blockchain proposes a series

of decision-making factors and a good documented basis for developers and investors through the efficient allocation of resources in the field of research and development, the identification of academic partners and the understanding of possible technological risks that may arise from the use of smart contracts.

Research limitations

The first limitation identified is related to the selection operated in the database. Although the extraction was carried out using the Web of Science platform, which represents a reliable and representative academic source, it is possible that certain publications from local journals or conferences that are less visible in international indexing may not have been included in the set.

A second limitation is related to the keywords used as extraction criteria, as there is a possibility that important publications that used terms different from those introduced in the data filtering stage but addressed topics similar to the present one may not have been included.

Therefore, the proposal for future research would be to expand the database, as well as the reference period, to contribute to a more comprehensive approach and to build a representative overview of the topic of smart contracts in blockchain technology.

Conclusions

Building on the mentions made in the previous sections, the bibliometric analysis carried out highlights an increase in the number of specialised publications on blockchain technology and smart contracts during the period 2015-2024. The main approaches focus on security and scalability, illustrating the challenges that society faces from a technological perspective.

On the one hand, according to the results obtained from the analysis, a considerable increase in the number of publications was illustrated, especially after 2017, due to the technological progress of blockchain. This growth marks the growing interest of scientific communities in the use of smart contracts in a variety of academic fields and disciplines.

On the other hand, there is a concentration of authors addressing the subject of blockchain technologies and smart contracts, the scientific core being influential, built up of researchers from diverse regions (Europe, Asia, America). The geographical distribution of publications highlights the need for the active involvement of emerging economies in adopting smart contracts, ensuring a balance at the global level. This is particularly notable, as developed regions have been slow to implement this type of contract and technology during the period under analysis. Thus, the subject addressed is highly globalised and interconnected.

From a theoretical point of view, researchers are focusing on issues related to security and formal verification, later focusing on practical applications aimed at DeFi, digital governance, and decentralised identity.

According to the analyses, the most frequently addressed topics are related to methods for preventing vulnerabilities, the development of automated auditing tools, and the integration of smart contracts into DeFi ecosystems.

In conclusion, constant monitoring of changes in this area is crucial for identifying new trends and challenges associated with smart contracts in blockchain, these contracts constitute a foundation in the architecture of new digital ecosystems.

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