At the end of 2019, a severe respiratory syndrome named COVID-19 is started to be transmitted in the world and it has rapidly spread to a global pandemic. Every day, a series of data are collected for real-time monitoring of the development of this pandemic. The data validation and the verification are becoming very important to manage the pandemic and give recommendations to the people. Nevertheless, sometimes, it is not possible to guarantee the truthfulness of such data and some information may be lost during collection. Due to its characteristics, the Blockchain technology can become an important support to face the COVID-19 pandemic. In this regard, the aim of this research is to propose a literature review to understand how the blockchain technology has been used for health care and supply chain management to guarantee an efficient tracking, tracking, and monitoring solution, ensure a transparent and safe data transmission, and to delineate the emerging future research directions.

1. Introduction

Toward the end of 2019, the first infections of COVID-19 were discovered causing a quickly global health emergency around the world. To limit and control the spread of this pandemic, every day, a large amount of data are collected such as the number of positive and negative tests, deaths, hospital beds occupied, patients hospitalized.[1] The process of validating and verifying the monitored data is crucial for managing the pandemic and providing recommendations to the public.[2] However, the collection of information can lead to some problems as it is not always possible to guarantee the veracity of such data and information may be lost during collection[3] or may be subject to cyberattacks. Radanliev et al.[4] state that the digitization of the healthcare system, will increase the risk of cyberattack on IoT medical implants. The Blockchain technology (BC) could become an important support to face the COVID-19 pandemic since it would enable efficient tracking and monitoring solutions, ensure a transparent flow of products and information, and maintain a high level of data security through reliable data encryption mechanisms, data integrity, and network resilience.[5] The BC, which literally means chain of blocks, is a large digital ledger in which entries are grouped in chronologically linked blocks. To fully understand it, it is useful to think of the blockchain as a huge, share database to which new blocks can be added gradually and to which everyone can access; it cannot be changed, and its security is guaranteed by cryptographic encryption tools.[6] This technology has already entered many industrial sectors, revolutionizing them completely and in the recent past, the adoption of the BC in the healthcare domain has increased tremendously.[7] In this regard, Marbouh et al.[8] have analyzed the opportunities provided by the BC to face the problem of the falsification of data on COVID-19 pandemic collected from various external sources. Hijji et al.[9] have carried out a Literature Review on cybersecurity attack during the pandemic proposing the BC technology as safe infrastructure. This is in line with the result proposed by Mbunge et al.[10] where the use of emerging technologies to address the pandemic have been reviewed. Mehraeen et al.[11] have conducted a literature review aimed at identifying the main challenges for policymakers when facing pandemic crisis and how new information technologies could help them to react.

Starting from the above considerations, the main purpose of this paper is to examine the application of the blockchain technology in managing pandemics; specifically, its use and application in managing the Covid-19 pandemic.

The paper is organized as follows: in Section 1, introduction and scope of the work are provided. Section 2 shows the methodology used. Finally, Section 3 presents the numerical results, and Section 4 summarizes the main conclusions and future remarks.

2. Experimental Section

The research was conducted in February 2021 using the Scopus database. In order to identify the relevant studies to be reviewed, different steps have been carried out.

Concerning the definition of the inclusion criteria, we have only included studies:
1) written in English and published in peer-reviewed international journals.
2) expressly focused on the engineering, health, and management sectors.

Concerning the definition of the keywords, an appropriate set of terms relating to two topics (blockchain and pandemic) were combined for making the search. These terms were searched for in the article title, abstract or keywords of the paper, to ensure that the study focused on the chosen theme. The list of queries used for the search is summarized in Table 1.

The six queries returned 162 papers; 65 duplicated studies were removed and a total of 97 documents were retrieved and screened by reading the full document, to ensure that they comply with the inclusion criteria. After reading, some papers were excluded from the original sample because they were out of scope for the present review since the central topic was different from blockchain and pandemic management. The screening therefore led to exclude 62 papers overall, resulting in a final sample of 35 papers.

2.1. Paper Classification

The 35 papers belonging to the final sample were further classified according to the following fields:

1) Paper type, which includes “quantitative papers” (containing mathematical models); “qualitative papers” (papers that do not provide mathematical equations); “empirical papers” (papers that present case study and experimental data).
2) Main and Secondary topic, which reflect the paper macrotheme. Three main categories have been identified: Blockchain, Covid-19, and IoT. As a secondary topic, seven categories have been identified: 5G, Blockchain, Covid-19, Healthcare, IoT, and Risk Management.
3) Context, i.e., the sector in which the BC has been used; two macro categories have been identified: Healthcare Management and Supply Chain Management.
4) Use case, i.e., the BC use to face the pandemic. Three main applications have been identified reading the sample of papers: Tracing (real-time data about patient or good movements), Tracking (accurate and transparent information sharing and management), and Privacy protection (protect user identity).

3. Results

The timespan of the publication ranges from 2020 to 2021, according to the Covid-19 outbreak, and the numerosness of papers for year is in line with the time of the sample construction (early 2021) (Figure 1). It is evident that the number of articles is higher than the number of reviews. This is justified by the fact that the Covid-19 pandemic is a new phenomenon, and therefore, when the analysis was started few reviews had already been published.

The review papers were examined and described in Section 1; hence, these studies are not analyzed further. The remaining 31 papers have been classified according to the classification fields described in Section 2.1. Figure 2 shows that most of the papers are qualitative (65%). This result is expected since the pandemic is an emerging and unknown disaster, and therefore the development of quantitative models generally needs a deeper understanding of the phenomenon and the availability of reliable data. For the same reason, the newness of the phenomenon justifies the number of empirical studies.

The classification of the papers according to the topic is presented in Figure 3. In line with the keywords used for the search, many papers focus on the use of the Blockchain
technology to manage the pandemic (19 papers combine the theme “Blockchain” and “Covid-19,” resulting in 54.3% of the studies reviewed). The second most relevant macro-theme is the integration of Blockchain and covid-19 with IoT (Internet of Things), which is dealt with seven papers (20% of the sample).

Finally, by performing a manual selection of all the reviewed documents, 20 relevant documents were chosen for a further in-depth analysis. This analysis was used to discover the extent of the BC implementation to face the Covid-19. The results show that in 50% of the cases, the technology was used to improve the supply chain management performance, but only the 25% of papers proposes a solution for the healthcare management; the rest of the papers (25%) do not specify the context. In addition, Table 2 shows the context combined with the BC application. It is interesting to note that most of the papers focus on the use of the BC to guarantee the privacy, and secondly to assure transparency and improve trust, while the topic of tracing has not been studied in depth. The increasing application of BC to guarantee the privacy is probably due to the need of managing data belonging to humans.

### Table 2. Context vs. use case.

| Context               | BC Application |
|-----------------------|----------------|
|                       | Tracing | Tracking | Privacy |
| Health care Management| 3       | 4        | 6        |
| SC Management         | 3       | 9        | 8        |
| Not specified         | 4       | 2        | 3        |
| Total                 | 10      | 15       | 17       |

4. Conclusion

The paper has evaluated a literature review and has studied the potential of the application of the blockchain to improve the risk management related to crises such as pandemic. It is possible to underline that it is a useful technology for monitoring data with transparency and for sharing data with the total guarantee of privacy.

The use cases highlighted how this technology can guarantee the traceability of contacts, the continuous monitoring in different areas offering a practical support. The reviewed papers underline how, in a situation of chaos, increasing the reliability of information and storing news and data on a blockchain database could help in managing the risk and improve the resilience of the system. One of the restrictions of the study is the time in which the literature review was conducted. In this regard, the study should be expanded to include new researches that have emerged. Starting from the considerations above, future research should focus on the development of mathematical model or software simulation for risk management, the construction of quantitative models, including the use of the BC to improve the medical supply chain, and a strategical application on chaos situations. Particular attention should be paid to the topic of tracing, in terms of people, but also the trace of medical equipment, medicaments, vaccines, polymer products used in the treatment of COVID-19, or any goods with the aim of improving the performance of the health care sector during a pandemic.

**Conflict of Interest**

The authors declare no conflict of interest.

**Data Availability Statement**

Data sharing not applicable to this article, as no datasets were generated or analyzed during the current study.

**Keywords**

Blockchain, Covid-19, pandemic, review

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[1] A. Khurshid, JMI R Med. Inform. 2020, 8, e20477.
[2] A. De Luca, D. Perfetto, A. De Fenza, G. Petrone, F. Caputo, Procedia Struct. Integr. 2018, 12, 578.
[3] M. Guida, A. Manzoni, A. Zuppardi, F. Caputo, F. Marulo, A. De Luca, Multibody Syst. Dyn. 2018, 44, 191.
[4] P. Radañilev, D. De Rouge, C. Maple, U. Ani, AI and Ethics 2021, 1.
[5] N. Pandey, A. Pal, Int. J. Inf. Manag. 2020, 55, 102171.
[6] A. Hasselgren, K. Kralevska, D. Gligoroski, S. A. Pedersen, A. Faxvaag, Int. J. Med. Inform. 2020, 134, 104040.
[7] M. Hiwale, S. Phanasalkar, K. Kotecha, Sci. Technol. 2021, 1.
[8] D. Marbouh, T. Abbasi, F. Maasmi, I. A. Omar, M. S. Debe, K. Salah, Arab J. Sci. Eng. 2020, 45, 9895.
[9] M. Hijji, G. Alam, IEEE Access 2021, 9, 7152.
[10] E. Mbunge, B. Akinnuwasigbe, S. C. Fasho, A. S. Metfura, P. Mashwana, Hum. Behav. Emerg. 2021, 3, 25.
[11] M. Laggazian, M. Dadkhah, A. Mehraeen, Eur. J. Clin. Invest. 2020, 50, e13391.