Journal of Data Acquisition and Processing
ISSN: 1004-9037
https://sjcjycl.cn/
DOI: 10.5281/zenodo.98549926

# BLOCKCHAIN TECHNOLOGY IN SUSTAINABLE ENERGY MANAGEMENT SYSTEMS: COMPLEX PROPORTIONAL ASSESSMENT (COPRAS) METHOD

**D Ravindran** [1][ 0000-0003-1672-9552]
School of Management, Kristu Jayanti College (Autonomous), Bengaluru, Karnataka, India

**Stephen Deepak** [2] [0000-0002-2197-802X],
School of Management, Kristu Jayanti College (Autonomous), Bengaluru, Karnataka, India

**Prof. Arun Kumar**
Associate Professor, Management Area, NIIT University, Neemrana, Rajasthan

**Ranganathan S**
Research Scholar, PG& Research Dept of Computer science, Nehru Memorial College (Autonomous), Affiliated to Bharathidasan University, Puthanampatti, Trichy Tamil Nadu.

**Dr. V. Umadevi**
Research Supervisor, PG& Research Dept of Computer science, Nehru Memorial College (Autonomous), Affiliated to Bharathidasan University, Puthanampatti, Trichy Tamil Nadu.

**Mohd. Afjal**
Assistant Professor, VIT Business School, Vellore Institute of Technology, Vellore, India
**Corresponding Author: D.Ravindran*

**Abstract**

Blockchain technology has received a lot of attention from industry and academia due to its decentralization, stability, anonymity, and auditability. the use of blockchain technology in numerous fields and the difficulties associated with its deployment. There has been a thorough assessment of journal and research paper searches connected to blockchain technology. The foundational blockchain technology, which includes peer-to-peer networking, security, and consensus procedures, is not given as much attention as the currency itself. This essay makes the case that we should consider blockchain technology's potential applications outside of the realm of cash and investigate areas like secure document handling and digital IT administration. The usage of blockchain technology as just a foundation for numerous e-government applications and as a burgeoning support infrastructure demonstrates that it has the capacity to authenticate a variety of ongoing documents. The study's goal is to build the rough sets COPRAS method, which expresses alternatives' evaluation values in HFS form and presents information metrics for HFSs, such as variance and entropy measurements. The project was motivated by the abovementioned literature on HFSs. To estimate criteria weights, linear programming models based on the Shapley component are also suggested. Then, a quality service decision problem is used to illustrate the application of a suggested COBRAS technique. The TOPSIS approach, one of the most useful MCDM techniques, is explained in

terms of the Shapley function's distance or difference. In order to compare the suggested Shapley-COPRAS approach with the Shapley-TOPSIS procedure and existing ones, a comparison framework is performed in the end. The alternatives are Electronic Health Records, Clinical Research, Medical Fraud Detection, Neuroscience Research and Pharmaceutical Industry and Research. the evaluation parameter is Decentralized, Transparent, Immutable, Autonomy, Open Source and Anonymity. the blockchain technology in healthcare using COPRAS. Pharmaceutical Industry and Research is got first rank, Neuroscience Research is got lowest rank.

**Keywords:** electric and hybrid electric propulsion, internal combustion engine (ICE), MCDM.

## 1. INTRODUCTION

With its initial implementation, the currency Bitcoins, which was created and presently has a market valuation of further than 100 billion Dollars, blockchain technology first came to the attention of the general public. Blockchain technology has developed dramatically over the past ten years and is currently used in a variety of contexts, such as Cryptocurrencies or Hyperledger Fabric, enabling distributed platforms to function with previously unheard-of adaptability. As a result, many academics and industry professionals are beginning to see the disruptive potential of blockchain technology beyond cryptocurrencies. In general, blockchain technology appeals to individuals as well as business and the public sector since it enables secure transactions without the use of middlemen. However, the majority of people still associate blockchain technology with Bitcoin. Additionally, it's commonly known that Bitcoin uses a lot of electricity. As a result, it is common to hear that blockchain technology generally has an issue with its energy usage. These claims could hinder or delay the mainstream implementation of blockchain technology given the ongoing discussions climate change - related and sustainability. pinpoints critical healthcare concerns and emphasises interoperability and patient-centered care. The following section outlines seven distinct healthcare scenarios, or use cases, where blockchain technology can be applied to lessen some of the major drawbacks. examines the design implications of four healthcare difficulties that blockchain-based systems face. We created a real case model that provides an illustration of how to handle the problems. highlights important design factors for creating Blockchain-based healthcare technology with a case scenario. summarises the most important things we've learnt from this. outlines potential future study areas for blockchain in the medical industry. The simple-to-understand and low-computing-required "complex proportionality estimation (COPRAS)" approach is a nice illustration. The COPRAS approach has been extensively applied in a variety of areas including market stability, building initiatives, the choice of low power windows, and social media platforms. Additionally, Das et al. and Ecer reported using an integrated AHP-COPRAS technique to evaluate the new media technology of seven Indian Institutes of Technology and to rate the calibre of online banking in Turkey. In assessing and rank hydraulic friction formulas, this work intends to provide a method that combines/integrates AHP and COPRAS. In order to measure and prioritize the friction formulas, the weights produced by the AHP approach are merged with COPRAS. A

comparison study with other approaches is also offered to confirm the applicability and use of this strategy. This approach will work well for creating the friction formulation with the best tribal features. In multi-attribute decision-making (MADM) difficulties, multi-attribute decision analysis has been investigated to assist decision-makers in reaching their final conclusions. This essay tries to describe Complex Proportionality Assessment (COPRAS), a straightforward, methodical, and rational approach to decision-making for the manufacturing sector. The MADM Techniques section includes COPRAS. Using the COPRAS technique, Zavadskas, Zavadskas, and Kaklauskas chose options based on their significance and level of applicability. This method's effectiveness can be attributed to both its ease of use and unique affinity. Only a few successful COBRAS technique implementations in decision-making domains like "construction, sustainability assessment, building construction, road design, and education" have been documented in the literature. The majority of consumers don't think about the alternatives' quality standards. Here, a more effective COBRAS technique is described.

## 2. BLOCKCHAIN TECHNOLOGY IN HEALTHCARE

Blockchain technology (BCT) were initially developed for its efficiency in the economics and cryptocurrency spheres, but it is now being used in a wide range of industries, including the biomedical industry. Due to the extensive timeline of postintervention, follow-up, and rehabilitation processes, the prevalence of such hazards may be higher in patients suffering from chronic diseases. In order to ensure efficient treatment, keeping an up-to-date clinical history has become crucial. He suggested a blockchain-based architecture for managing, storing, and exchanging electronic health records of cancer victims to get around these restrictions. They embraced blockchain technology, which gave them access to, management over, and storage of secure patient data. In order to access and control the privacy and security data and experience in medical practises, such specified mechanisms can be used to put blockchain technology into effect. The blockchain-based Estonian Medical Achievement initiative is another historical milestone. With its proposal to keep millions of medical information private while also making them freely accessible to healthcare professionals and insurance firms, Estonia rose to prominence as a world powerhouse in blockchain technology. A solid assurance for patients may be provided by employing blockchain technology to make their medical records indelible and unchangeable, which is the driving force for the global adoption of this technology in medicine. Every access or remediation attempt is immediately identified and authenticated through the blockchain. In a blockchain-based approach, relationships between people are characterised primarily by a lack of trust. Blockchain is referred to be a "trust engine" by The Economist, which suggests it handles interpersonal trust concerns. In other sense, a blockchain-based economic system functions devoid of human interaction, which reduces the level of trust in business dealings. In the past, trust has been the foundation of commerce, frequently including expensive trusted third parties. By doing away with middlemen and lowering operational costs, blockchain technology can improve the effectiveness of the sharing business. The most fundamental commercial transactions in the world can be rebuilt using blockchain technology. New forms of digital communication that

rely less on trust can also be discovered. Blockchain, as Harald noted, is a technology approach to decentralization and collaborative database maintenance that is completely trustworthy. The Kingdom Blockchain Technology and Product Offered White Paper by China's Department of Information Technology presents the idea of blockchain in both a restricted and general sense. Blockchain refers to a certain sort of chain file system in which data blocks are connected chronologically, and cryptography is employed to ensure the distributed ledger's error-free update and imperviousness. Blockchain, a novel application mode of computer technology that combines distributed data storage, point-to-point transaction, consensus procedures, and encryption methods, is the general definition of this technology. This technology, which is built on a night before going to bed "block and chain" dataset, employs distributed node clustering techniques to add & update information, cryptography to safeguard transfer of data and use, and smart contracts created by programmable script code to programmed and edit. Information. This definition makes the blockchain technology's workings and relatively intricate functions clearer.

**Electronic Health Records:** An authorized distributed ledger on a blockchain ensures the integrity of a digital EHR from the point of data creation to the perspective of data retrieval without the need for human intervention.

**Clinical Research:** A decentralized secure framework for informational partnerships that may occur in clinical research is introduced by blockchain. This enables data to be safely exchanged with university researchers.

**Medical Fraud Detection:** Because it prevents transaction duplicate or alteration, blockchain's immutability aids in fraud detection and ultimately enables transparent and safe transactions.

**Neuroscience Research:** Blockchain technology has the potential to advance a number of new applications that involve brain enhancement, brain simulation, and brain thinking. A medium must be used to store the entire digitalized human brain, and here is where blockchain innovation comes into play.

**Pharmaceutical Industry and Research:** The pharmaceutical supply chain is monitored at every stage thanks to the power of comprehensive tracing provided by blockchain: To prevent the forging or theft of goods, it is commonly determined where the medication came from, what components it contains, and who owns it.

## 3. MATERIALS AND METHOD

These techniques are designed to make it simple for decision-makers to choose the preferred options. Among such techniques, COBRAS has recently received the most investigations. The Cobras technique finds a response ratio is the ratio of something like the ultimate plan to some of the worst solution ratio as a compromise approach. The COPRAS method, in contrast to other MADM techniques, is based on a chronological ranking and utilises both utility and importance scales for rationalization. The COPRAS-based technique has a quicker evaluation time, is simpler to use, and has superior dependability, according to a comparison study by Chatterjee et al. Compared to other techniques like AHP, VIKOR, and TOPSIS, graphic elucidation. Cobras are used for a wide variety of purposes in literature. The COPRAS

approach, for instance, was used to analyse environmental problems by Zolfani et al. According to the curved fuzzy linguistic COBRAS technique, Zheng et al. explored the severity appraisal of lung function. Additionally, Shidia et al used Cobras to resolve the hydrogen movement roll-up site selection issue. Fuzzy COPRAS was used by Garg et al. to construct a MADM-based parametric technique for choosing and rating e-learning websites. Based on COPRAS, Garg and Nancy suggested various single-valued neuromorphic decision-making algorithms for probabilistic linguistics. The literature research reviews cited above all demonstrate that the COPRAS approach does not successfully model the interdependence of several input arguments. However, when analyzing the findings, this problem should be taken into account. It is therefore necessary to provide an aggregated operator that can demonstrably demonstrate the dependency of several input arguments in order to address this issue. We adjust the COBRAS approach to better fit a dual fuzzy environment based on this viewpoint. The advantages of COPRAS include the following: It evaluates rates for both the best and worst solutions simultaneously; It delivers results significantly faster than all the other MCDM methods; This system is very straightforward and simple to comprehend. Several works have concentrated on using the traditional COBRAS approach. The researchers had to take the COPRAS approach to this level because of the inherent uncertainty in the attribute value and its weights. With the use of fuzzy COPRAS and a new hybrid model, Foulage et al. evaluated job tactics. To address the hesitant fuzzy soft decision-making issue, Peng and Dai created MABAC (Multi-Attributive Border Approximated Area Assessment), WASPAS (Weighted Aggregated Product Estimation), and Complex Proportion Estimation (COPRAS). These benefits have led to the COPRAS method's widespread application in recent years across a range of decision-making domains. The COPRAS approach chooses the best and worst options for a solution. For use with interval-valued intuitionistic fuzzy sets in group decision-making, Razavi Hajaga et al. proposed an expanded version of the Cobras approach. To address the supplier selection problem, Ghorabaee et al. adapted the COPRAS method to group decision making with interval type-2 fuzzy sets. The references can be used to get a thorough explanation of the Cobras approach. Because the COPRAS technique assesses both the market value of the alternatives and their utility level, which indicates how many better then the alternatives are relative to the other alternatives used as comparisons, it surpasses the majority of the existing classical MADM methods. The Cobras technique resolves MCDM issues including conflicting and misaligned criteria. It seeks to help decision-makers come to a choice. The Fuzzy Cobras approach, however, can produce subpar results and be expensive. The COPRAS method is expanded in a fuzzy environment in this study to suggest a strategy for dealing with FMCGDM issues in the context of suggested symHFNs. A fire and emergency alternate assessment problem is used to illustrate how the proposed method might be applied. The suggested approach offers a practical means of dealing with FMCGDM issues in a more adaptable and effective way.

## 4. RESULT AND DISCUSSION

**TABLE 1.** Applications of blockchain technology in healthcare

| | **Decentralized** | **Transparent** | **Immutable** | **Autonomy** | **Open Source** | **Anonymity** |
|---|---|---|---|---|---|---|
| Electronic Health Records | 120.87 | 186.78 | 139.53 | 129.15 | 154.87 | 122.05 |
| Clinical Research | 165.90 | 143.71 | 142.97 | 133.69 | 145.89 | 127.30 |
| Medical Fraud Detection | 176.28 | 163.98 | 122.58 | 129.18 | 178.00 | 123.10 |
| Neuroscience Research | 123.17 | 149.94 | 128.28 | 124.60 | 152.09 | 117.59 |
| Pharmaceutical Industry and Research | 133.33 | 153.98 | 186.41 | 127.96 | 138.42 | 118.89 |

Table 1 shows the blockchain technology in healthcare using COPRAS method for the alternatives are Electronic Health Records, Clinical Research, Medical Fraud Detection, Neuroscience Research and Pharmaceutical Industry and Research. the evaluation parameter is Decentralized, Transparent, Immutable, Autonomy, Open Source and Anonymity.

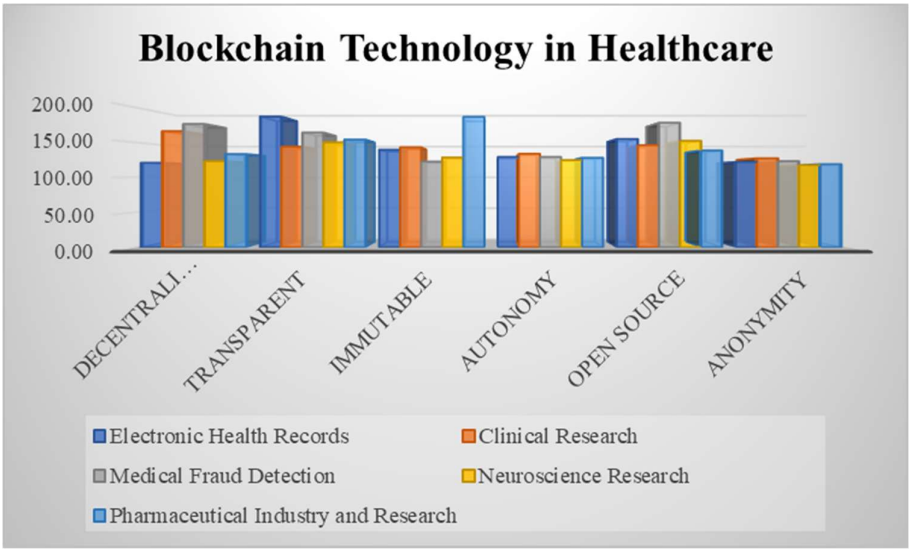


**FIGURE 1.** Blockchain technology in healthcare

**TABLE 2.** Normalized Data

| | Normalized Data | | | | | |
|---|---|---|---|---|---|---|
| Electronic Health Records | 0.1680 | 0.2339 | 0.1939 | 0.2004 | 0.2013 | 0.2004 |
| Clinical Research | 0.2306 | 0.1800 | 0.1986 | 0.2074 | 0.1896 | 0.2091 |
| Medical Fraud Detection | 0.2450 | 0.2054 | 0.1703 | 0.2004 | 0.2314 | 0.2022 |
| Neuroscience Research | 0.1712 | 0.1878 | 0.1782 | 0.1933 | 0.1977 | 0.1931 |
| Pharmaceutical Industry and Research | 0.1853 | 0.1929 | 0.2590 | 0.1985 | 0.1799 | 0.1952 |

Table 2 shows the normalized data which is calculated from the data set each value is calculated by the same value on the table 1. Blockchain technology in healthcare divided by the sum of the column of the above tabulation.

**TABLE 3.** Weight

| | Weight | | | | | |
|---|---|---|---|---|---|---|
| Electronic Health Records | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Clinical Research | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Medical Fraud Detection | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Neuroscience Research | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Pharmaceutical Industry and Research | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |

Table 3 shows the weight of the weight is equal for all the value in the set of data in the table 1. The weight is multiplied with the previous table to get the next value.

**TABLE 4.** Weighted normalized decision matrix

| | Weighted normalized decision matrix | | | | | |
|---|---|---|---|---|---|---|
| Electronic Health Records | 0.04 | 0.06 | 0.05 | 0.05 | 0.05 | 0.05 |
| Clinical Research | 0.06 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Medical Fraud Detection | 0.06 | 0.05 | 0.04 | 0.05 | 0.06 | 0.05 |
| Neuroscience Research | 0.04 | 0.05 | 0.04 | 0.05 | 0.05 | 0.05 |
| Pharmaceutical Industry and Research | 0.05 | 0.05 | 0.06 | 0.05 | 0.04 | 0.05 |

Table 4 shows the weighted normalization decision matrix it is calculated by multiplying the weight and performance value in table 2 and table 3.

**TABLE 5.** Bi, Ci and Min (Ci)/Ci

| | Bi | Ci | Min (Ci)/Ci |
|---|---|---|---|
| Electronic Health Records | 0.149 | 0.151 | 0.9528 |
| Clinical Research | 0.152 | 0.152 | 0.9465 |
| Medical Fraud Detection | 0.155 | 0.158 | 0.9049 |
| Neuroscience Research | 0.134 | 0.146 | 0.9822 |

| | | | |
|---|---|---|---|
| Pharmaceutical Industry and Research | 0.159 | 0.143 | 1.0000 |

Table 5 shows the value of Bi, Ci, Min (Ci)/Ci the Bi is calculated from the sum of the Electronic Health Records, Clinical Research, Medical Fraud Detection, Neuroscience Research and Pharmaceutical Industry and Research. The Ci is calculated from the sum formula used.

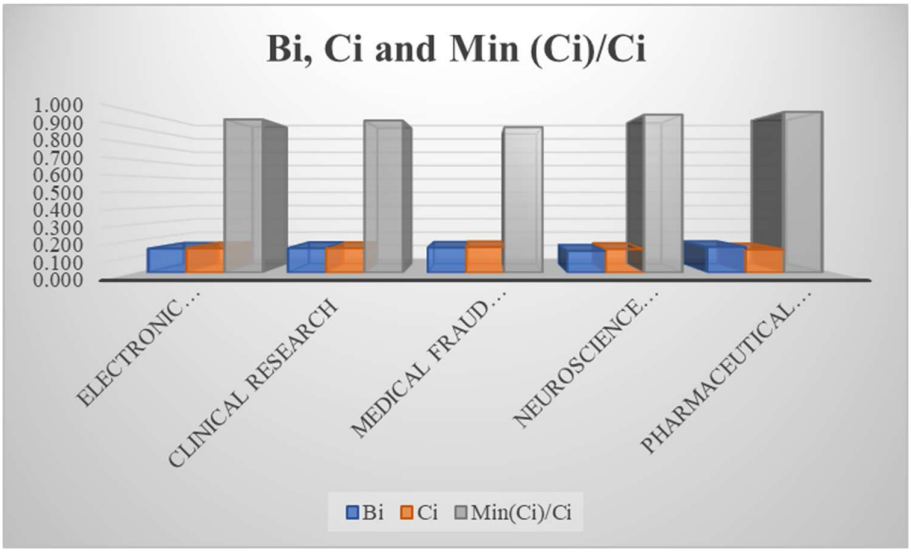


**FIGURE 2.** Bi, Ci and Min (Ci)/Ci

Figure 2 shows the value of Bi, Ci, Min (Ci)/Ci the Bi is calculated from the sum of the Electronic Health Records, Clinical Research, Medical Fraud Detection, Neuroscience Research and Pharmaceutical Industry and Research. The Ci is calculated from the sum formula used.

**TABLE 6.** Qi, Ui and Ui %

| | Qi | Ui | Ui % |
|---|---|---|---|
| Electronic Health Records | 0.298 | 94.3866 | 94% |
| Clinical Research | 0.301 | 95.1368 | 95% |
| Medical Fraud Detection | 0.297 | 93.9837 | 94% |
| Neuroscience Research | 0.288 | 91.2078 | 91% |
| Pharmaceutical Industry and Research | 0.316 | 100.0000 | 100% |

Table 6 shows the Qi, Ui and Ui % value Qi sum, minimum formulas using this table.

**TABLE 7.** Final result of ranking

| | Rank |
|---|---|
| Electronic Health Records | 3 |

| | |
|---|---|
| Clinical Research | 2 |
| Medical Fraud Detection | 4 |
| Neuroscience Research | 5 |
| Pharmaceutical Industry and Research | 1 |

Table 7 final result of the blockchain technology in healthcare using COPRAS. Electronic Health Records is got third rank, Clinical Research is got second rank, Medical Fraud Detection is got forth rank, Neuroscience Research is got fifth rank and Pharmaceutical Industry and Research is got first rank. The final result is done by using the COPRAS method.

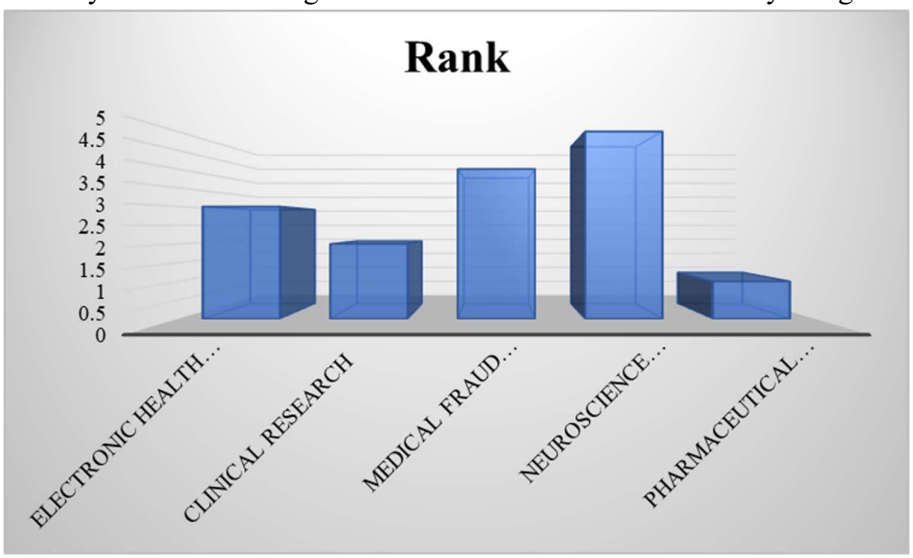


**FIGURE 3.** Final rank

Shows the figure 3 final result of the blockchain technology in healthcare using COPRAS. Electronic Health Records is got third rank, Clinical Research is got second rank, Medical Fraud Detection is got forth rank, Neuroscience Research is got fifth rank and Pharmaceutical Industry and Research is got first rank.

## 5. CONCLUSION

The research on the applicability of blockchain technology as well as the energy internet is presented in this paper. The results of this work can be summed up as follows in light of the outcomes and important findings of the existing literature: It is possible to find out whether blockchain technology is so popular everywhere. The value transfer mechanism becomes separate of the network nodes because it can build confidence amongst network nodes. A distributed node consensus mechanism, which is transparent and privacy-preserving, is used to add or update network data. The adoption of encryption methods also guarantees data security. Block chain is a practical tool that lowers costs and boosts value transfer efficiency.

• There are more individuals and energy forms in the energy web. It is a new kind of energy supply system that offers flexible access to diverse clean energy sources as well as a workable

option for large-scale use. It has multi-energy complementarity and is highly integrated with energy and information. The Energy Internet and Smart contract work well together. As it may address many issues impeding the growth of the energy internet, such as the control and administration of distributed sustainable forms of energy, the implementation of blockchains in the energy internet presents a promising potential for the development of the energy internet. In this study, the obstacles and a number of real-world examples are summarized. Calculations may be made with adequate accuracy using the multi-objective assessment method COPRAS, and the relative importance of the criteria can also be determined. When determining the weighting criteria for data correctness provided by the entropy approach, the minimization and maximizing of index values are assessed. Useful data is generated for further study and investigations after properly conducting calculations and combining the entropy and COPRAS methodologies. The best material must be chosen in every organization's material management policy. Fuzzy COPRAS is utilized in this work to handle various and challenging choices with respect to numerous criteria using group decision-making. The COPRAS method of fuzzy group decision-making serves as an example of the subject selection problem. To choose the best option among seven material categories for making wagon panels, a company assembled an expert panel with four decision-makers. Types of qualitative significant characteristics, which are all presented as quantitative representations, will be taken into consideration by the committee. Aluminum alloys are said to be the perfect material for light rail cars because of the dubious Cobras approach. The chosen items are essentially consistent with earlier investigations. using COPRAS and blockchain technologies in healthcare. Pharmaceutical Industry and Research is got first rank, Neuroscience Research is got lowest rank.

## REFERENCE

[1]. Meng, Weizhi, Elmar Wolfgang Tischhauser, Qingju Wang, Yu Wang, and Jinguang Han. "When intrusion detection meets blockchain technology: a review." Ieee Access 6 (2018): 10179-10188.

[2]. Wu, Jiani, and Nguyen Khoi Tran. "Application of blockchain technology in sustainable energy systems: An overview." Sustainability 10, no. 9 (2018): 3067.

[3]. Ishmaev, Georgy. "Blockchain technology as an institution of property." Metaphilosophy 48, no. 5 (2017): 666-686.

[4]. Ølnes, Svein, and Arild Jansen. "Blockchain technology as s support infrastructure in e-government." In Electronic Government: 16th IFIP WG 8.5 International Conference, EGOV 2017, St. Petersburg, Russia, September 4-7, 2017, Proceedings 16, pp. 215-227. Springer International Publishing, 2017.

[5]. Lemieux, Victoria Louise. "Trusting records: is Blockchain technology the answer?." Records Management Journal (2016).

[6]. Roman-Belmonte, Juan M., Hortensia De la Corte-Rodriguez, and E. Carlos Rodriguez-Merchan. "How blockchain technology can change medicine." Postgraduate medicine 130, no. 4 (2018): 420-427.

[7]. Zhang, Peng, Douglas C. Schmidt, Jules White, and Gunther Lenz. "Blockchain technology use cases in healthcare." In Advances in computers, vol. 111, pp. 1-41. Elsevier, 2018.
[8]. Mohanta, Bhabendu Kumar, Debasish Jena, Soumyashree S. Panda, and Srichandan Sobhanayak. "Blockchain technology: A survey on applications and security privacy challenges." Internet of Things 8 (2019): 100107.
[9]. Wright, Aaron, and Primavera De Filippi. "Decentralized blockchain technology and the rise of lex cryptographia." Available at SSRN 2580664 (2015).
[10]. Mohanta, Bhabendu Kumar, Soumyashree S. Panda, and Debasish Jena. "An overview of smart contract and use cases in blockchain technology." In 2018 9th international conference on computing, communication and networking technologies (ICCCNT), pp. 1-4. IEEE, 2018.
[11]. Sedlmeir, Johannes, Hans Ulrich Buhl, Gilbert Fridgen, and Robert Keller. "The energy consumption of blockchain technology: Beyond myth." Business & Information Systems Engineering 62, no. 6 (2020): 599-608.
[12]. Cole, Rosanna, Mark Stevenson, and James Aitken. "Blockchain technology: implications for operations and supply chain management." Supply Chain Management: An International Journal 24, no. 4 (2019): 469-483.
[13]. Sun, Jianjun, Jiaqi Yan, and Kem ZK Zhang. "Blockchain-based sharing services: What blockchain technology can contribute to smart cities." Financial Innovation 2, no. 1 (2016): 1-9.
[14]. Min, Hokey. "Blockchain technology for enhancing supply chain resilience." Business Horizons 62, no. 1 (2019): 35-45.
[15]. Siyal, Asad Ali, Aisha Zahid Junejo, Muhammad Zawish, Kainat Ahmed, Aiman Khalil, and Georgia Soursou. "Applications of blockchain technology in medicine and healthcare: Challenges and future perspectives." Cryptography 3, no. 1 (2019): 3.
[16]. Turk, Žiga, and Robert Klinc. "Potentials of blockchain technology for construction management." Procedia engineering 196 (2017): 638-645.
[17]. Ünver, Muharrem, and Ibrahim Cil. "Material selection by using fuzzy complex proportional assessment." Emerging Materials Research 9, no. 1 (2020): 93-98.
[18]. Chatterjee, Prasenjit, Vijay Manikrao Athawale, and Shankar Chakraborty. "Materials selection using complex proportional assessment and evaluation of mixed data methods." Materials & Design 32, no. 2 (2011): 851-860.
[19]. Saha, Abhijit, and Himadri Majumder. "Multi criteria selection of optimal machining parameter in turning operation using comprehensive grey complex proportional assessment method for ASTM A36." In International Journal of Engineering Research in Africa, vol. 23, pp. 24-32. Trans Tech Publications Ltd, 2016.
[20]. Keshavarz Ghorabaee, Mehdi, Maghsoud Amiri, Jamshid Salehi Sadaghiani, and Golnoosh Hassani Goodarzi. "Multiple criteria group decision-making for supplier selection based on COPRAS method with interval type-2 fuzzy sets." The International Journal of Advanced Manufacturing Technology 75 (2014): 1115-1130.

[21]. Mishra, Arunodaya Raj, Pratibha Rani, and Kamal Raj Pardasani. "Multiple-criteria decision-making for service quality selection based on Shapley COPRAS method under hesitant fuzzy sets." Granular Computing 4 (2019): 435-449.
[22]. Balali, Amirhossein, Alireza Valipour, Rodger Edwards, and Robert Moehler. "Ranking effective risks on human resources threats in natural gas supply projects using ANP-COPRAS method: Case study of Shiraz." Reliability Engineering & System Safety 208 (2021): 107442.
[23]. Vahdani, Behnam, S. Meysam Mousavi, R. Tavakkoli-Moghaddam, A. Ghodratnama, and Mehrdad Mohammadi. "Robot selection by a multiple criteria complex proportional assessment method under an interval-valued fuzzy environment." The International Journal of Advanced Manufacturing Technology 73 (2014): 687-697.
[24]. Stefano, Nara Medianeira, Nelson Casarotto Filho, Lizandra Garcia Lupi Vergara, and Rodrigo Ulisses Garbin da Rocha. "COPRAS (Complex Proportional Assessment): state of the art research and its applications." IEEE Latin America Transactions 13, no. 12 (2015): 3899-3906.
[25]. Gadakh, Vijay S. "Application of complex proportional assessment method for vendor selection." International Journal of Logistics Research and Applications 17, no. 1 (2014): 23-34.
[26]. Singh, Tej, Amar Patnaik, Gusztáv Fekete, Ranchan Chauhan, and Brijesh Gangil. "Application of hybrid analytical hierarchy process and complex proportional assessment approach for optimal design of brake friction materials." Polymer Composites 40, no. 4 (2019): 1602-1608.
[27]. Kildienė, Simona, Arturas Kaklauskas, and Edmundas Kazimieras Zavadskas. "COPRAS based comparative analysis of the European country management capabilities within the construction sector in the time of crisis." Journal of Business Economics and Management 12, no. 2 (2011): 417-434.
[28]. Dorfeshan, Yahya, and S. Meysam Mousavi. "A group TOPSIS-COPRAS methodology with Pythagorean fuzzy sets considering weights of experts for project critical path problem." Journal of Intelligent & Fuzzy Systems 36, no. 2 (2019): 1375-1387.