SELECTION OF SCRYPT ALGORITHM ASICS USING THE WEIGHTED AGGREGATED SUM PRODUCT ASSESSMENT (WASPAS) METHOD

Maulana Asykari Muhammad [1], Ryan Prananda Hikmahanto [2], Muhammad Zidan Fatonie [3]
[1,2] Sistem Informasi, UIN Jakarta Jl. Ir. H. Djuanda No. 95, Cempaka Putih,
Ciputat Timur, Tangerang Selatan, Banten, Indonesia
[3] Computer Science, BINUS University JL Kebon Jeruk raya No. 27,
Jakarta Barat 11530, Indonesia
maulana.asykari22@mhs.uinjkt.ac.id

ABSTRACT

The cryptocurrency mining industry faces significant challenges due to the increasing difficulty of the Scrypt algorithm, which necessitates highly efficient hardware to maintain profitability. Selecting the optimal Application-Specific Integrated Circuit (ASIC) is a complex Multi-Criteria Decision Making (MCDM) problem because it involves conflicting variables such as hashrate, power consumption, energy efficiency, price, and daily profit. This study aims to assess this complexity and provide a systematic decision-making framework by determining the most optimal ASIC device for the Scrypt algorithm. We implemented the Weighted Aggregated Sum Product Assessment (WASPAS) method, combining the Weighted Sum Model (WSM) and Weighted Product Model (WPM) to evaluate and rank ten recent ASIC models to enhance ranking accuracy and stability. The results indicated the Bitmain Antminer L9 (16 GH/s) as the optimal device with a preference value of 0.742. Conversely, the device with the highest raw hashrate, the VolcMiner D1 Hydro, only ranked 7th. This proves that superior computational speed does not guarantee operational viability when energy efficiency and investment costs are factored in. These findings can serve as a reference for a systematic decision-making framework for miners to prioritize sustainable hardware, and provide technical insights for manufacturers regarding market preferences for energy-efficient designs.

Keywords: *ASIC, WASPAS, Weighted Sum Model, Weighted Product Model*

1. INTRODUCTION

Cryptocurrency has developed into a global phenomenon and a significant industry in recent years [1]. The growth is reflected in the increasing number of users and market capitalization globally [2]. However, this expansion coincides with a significant rise in mining difficulty, making it harder to obtain profits. This occurs due to intensified competition and the complexity of the hashing algorithms used. Previous studies [3] [4] explain that while the SHA256 algorithm is dominated by Bitcoin, the Scrypt algorithm is used by other popular cryptocurrencies such as Litecoin (LTC) and Dogecoin (DOGE). Notably, the mining difficulty level for Litecoin has increased by an average of 3.86% over the last 90 days, meaning more computational power is required to find blocks and earn rewards [5].

Although scrypt was designed to be more memory-hard and less susceptible to ASIC dominance initially. Ever since the market evolved and ASICs for the scrypt algorithm are widely available [6], making selecting the right ASIC crucial. As explained by Stepanova et al. [7], miners continuously seek ways to optimize the efficiency and profitability of their operations. Furthermore, in the context of Green IT adoption and sustainability, selecting hardware with high energy efficiency is mandatory to minimize environmental impact while maximizing economic returns [8], [9], [10], [11]. Yaish et al. [12] add that determining mining machines with Proof of Work consensus involves many choices due to the numerous manufacturers and resellers releasing ASICs simultaneously. Therefore, a decision-making algorithm is needed to address this complexity.

WASPAS method is an MCDM method known for its capability to evaluate alternatives based on various criteria, both qualitative and quantitative, as well as the importance weights of each criterion [13]. This method combines the principles of WSM and WPM. The combination is specifically chosen to overcome the limitations of using single methods; for instance, WPM can be severely penalized if a criterion value is zero, which zeroes out the entire product. By integrating WSM, WASPAS mitigates this risk and provides higher ranking accuracy and stability compared to using WSM or WPM individually [14], [15].

Based on the context outlined, this research aims to implement the WASPAS method in determining the best ASIC for the Scrypt algorithm. Through this implementation, this study may offer a measurable decision-making framework that assists miners in selecting hardware with high efficiency, while also providing insights for manufacturers regarding market preferences.

2. LITERATURE REVIEW

Cryptocurrency mining operates through the Proof of Work (PoW) consensus mechanism to validate transactions and secure the network. As explained by Yaish and Zohar [12], the validators (miners) in this mechanism must solve complex cryptographic puzzles to obtain the right to add new blocks to the blockchain. To solve those puzzles, validators utilize specific hashing algorithms. Scrypt is the algorithm, used by Litecoin and Dogecoin, designed with memory-hard characteristics. Watkins [6] emphasizes, that this approach intentionally demands intensive memory (RAM) usage during the hashing process, which technically distinguishes it from the SHA-256 algorithm which primarily relies on CPU processing speed.

In modern mining operations, validator success is no longer determined solely by participation but by technical and economic efficiency. Schinckus et al. [16] highlight a close correlation between computational capacity or hashrates and energy consumption, where an increase in hashrates naturally increases electrical power requirements. Therefore, energy efficiency becomes a vital metric to ensure operational costs do not exceed revenue. Yazici et al. [9] add that the ability to switch to more efficient hardware is key to the sustainability of mining operations amidst asset price fluctuations. The necessity to balance technical variables (hashrate, power, efficiency) with economic variables (investment cost and estimated profit) is what subsequently drove the industry transition from general computing devices toward ASIC technology.

ASICs are integrated circuit hardware designed specifically to execute a single computational function, namely the hashing process within the cryptocurrency ecosystem. The emergence of ASICs is a direct industry response to increasing mining difficulty and the need for operational efficiency that can no longer be met by general-purpose computing devices [13], [14]. Research by [19], [20], outlines the evolution of mining hardware, beginning with the use of Central Processing Units (CPUs). Although CPUs possess high flexibility to handle various algorithms, their performance becomes inefficient at an industrial scale. Findings of [10] elucidate the phenomenon of miners shifting to Graphics Processing Units (GPUs), which offer parallel processing capabilities, followed by Field-Programmable Gate Arrays (FPGAs), which provide a balance between performance and power efficiency.

This evolution led to the development of ASICs, which are designed for specific algorithms like Scrypt to maximize speed. While fast, ASICs lack flexibility. Furthermore, high performance does not always mean low power consumption [9]. Modern ASICs require significant energy to produce high hash rates. This creates a trade-off where devices with the highest speeds often come with high power usage and high prices. Therefore, selecting a device requires a MCDM approach rather than relying on a single factor.

MCDM as a structure of systematic analysis for assessing among alternatives, in which the various criteria are simultaneously involved in and sometime conflicting. This method has been effectively shown to work on complex selection tasks in a variety of domains. For instance, Rahman et al. [21] applied an MCDM technique to provide objectivity in identifying zakat recipients, and Putra and Utami [22] employed the Multi-Attribute Utility Theory (MAUT) method to choose the top cryptocurrency exchange platforms.

Among several approaches, the WASPAS is characterized by its hybrid model approach where the WSM and WPM are combined to improve stability and accuracy of ranking. The reliability of this technique has also been tested under several operating conditions; it was employed by Radomska-Zalas [15] in technological process evaluation, Meliala et al. [23] used it for strategic business location selection, while Purba et al. [24] used it in personnel recruitment. In addition, Muhammad et al. [13] and İşler ve Çalık [14] have demonstrated that the WASPAS method is applicable for giving optimal investment decision suggestions, both in stock instruments and Sharia funds. Due to technique's uniform accuracy in many industries it was chosen for application in current ASIC device selection study. Figure 1 illustrate the research positions.

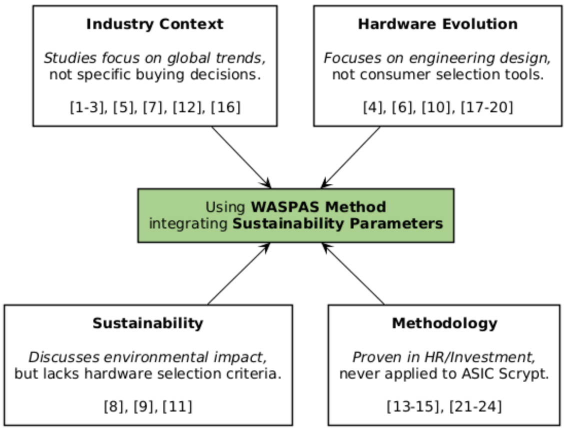

Figure 1. Research Positions

3. METHODS

In this study, we used secondary data obtained from the websites *asicminervalue.com* and *miningnow.com*. Both websites were chosen for their ease in detailing information regarding the ASIC machines to be selected. Regarding the research stages, the author conducted the research through three stages, illustrated in Figure 2. Based on the identification results, problems were found in determining the most optimal ASIC due to the many choices in the market with diverse specifications and the need to balance various important factors. The criteria used were elucidated by Table 2.

Table 2. ASIC Selection Criteria

Criteria	Attributes	Descriptions
C1	Hashrate	The ability of an ASIC to perform hash calculations per second, which directly affects mining speed.

Criteria	Attributes	Descriptions
C2	Power	The electrical power consumption of the ASIC, which impacts operational costs.
C3	Efficiency	The ratio between hashrate and power consumption, indicating how efficient the ASIC is in generating hashes per unit of power.
C4	Price	The initial purchase price of the ASIC.
C5	Profit	Estimated daily profit that can be generated by the ASIC, considering hashrate, power consumption, electricity costs, and cryptocurrency prices..

This stage includes a review of relevant literature. It involves searching and analyzing previous research related to ASIC selection, the Scrypt algorithm, or the application of the WASPAS method in similar contexts. The goal is to understand the methods previously used and find research gaps that can be filled by this study.

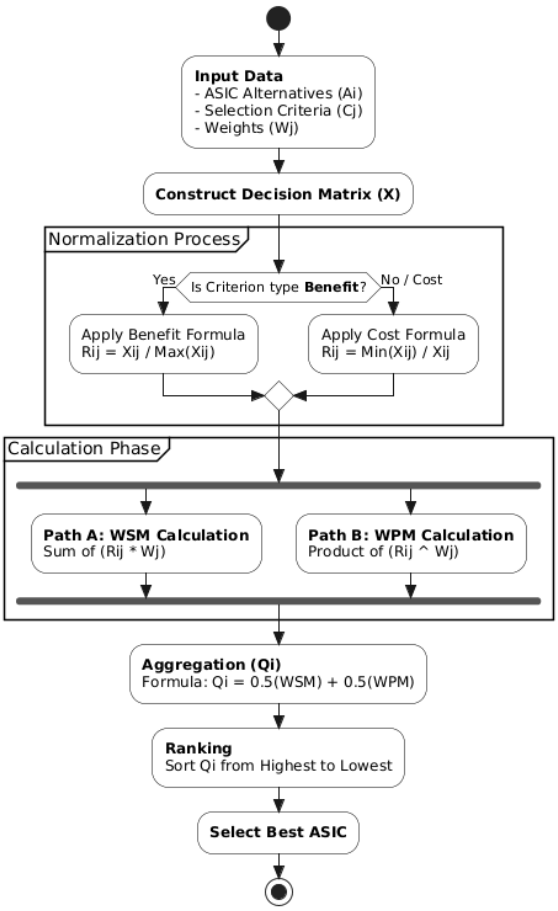

Figure 2. Research Flow

The data collection stage is carried out by selecting primary or secondary datasets that will later be used in the WASPAS calculation process. As described by [15], data can be in the form of location selection lists, student assessment lists, or computer component lists.

The WASPAS method begins by preparing a decision matrix. In a decision matrix, the determination of results is based on the evaluation of criteria from various existing options (alternatives)

$$\begin{pmatrix} x1 & \cdots & x1n \\ \vdots & \ddots & \vdots \\ xm1 & \cdots & xmn \end{pmatrix}$$

Figure 3. Example of decision matrix

After the decision matrix is created, the Rij values or criteria are normalized by determining whether the criteria fall into the *benefit* or *cost* category. The formulas for both are illustrated in formula (1) and formula (2)

$$R_{ij} = \frac{X_{ij}}{Max\ X_{ij}} \quad (1)$$

$$R_{ij} = \frac{Min\ X_{ij}}{X_{ij}} \quad (2)$$

The normalized Rij values are then collected in one table to facilitate the calculation of Qi or Alternatives. For each alternative, a calculation is performed using the formula described in formula (3).

$$Q_i = 0.5 \sum_{j=1}^{n} \bar{R}_{ij}\, w_j + 0.5 \prod_{j=1}^{n} (\bar{R}_{ij})^{wj} \quad (3)$$

3.1. Results and Conclusion

This stage contains an analysis of the best alternative calculation results. As described by [14], [22], all Qi values calculated at this stage for each alternative will be sorted from highest to lowest. The alternative with the highest Qi value will be identified as the best or most optimal alternative based on the determined criteria and weights. This analysis also includes further interpretation of the results, such as identifying the strengths and weaknesses of each alternative, as well as providing recommendations based on the findings. The conclusion drawn must accurately reflect the results of the WASPAS calculation and provide a clear understanding of the best choice in the context of the problem studied.

4. RESULTS AND DISCUSSION

Based on data collected through the websites asicminervalue.com and miningnow.com, 10 alternatives were found with five criteria described in Table 3, Table 4, Table 5.

Table 3. Criteria and Weight

Criteria	Description	Unit	Weight	Type
C1	Hashrate	Gigahash/s (Gh/s)	30%	Benefit
C2	Power	Watt (W)	20%	Cost
C3	Efficiency	Joule/Mh (J/Mh)	10%	Cost
C4	Price	USD ($)	20%	Cost
C5	Profit	USD/day ($/day)	20%	Benefit

Table 4. Alternatives

ID	Alternatives
A1	VolcMiner D1 Hydro (33 GH/s)
A2	ElphaPex DG2+ (20.5 GH/s)
A3	VolcMiner D1 Pro (18 GH/s)
A4	VolcMiner D1 (18.5 GH/s)
A5	Bitmain Antminer L9 (17 GH/s)
A6	Bitmain Antminer L9 (16 GH/s)
A7	ElphaPex DG2 (16 GH/s)
A8	Bitmain Antminer L9 (15 GH/s)
A9	ElphaPex DG Hydro 1 (20GH/s)
A10	ElphaPex DG1+ (14.4GH/s)

Table 5. Alternatives and Criteria

ID	C1	C2	C3	C4	C5
A1	33gh/S	9300w	0.28j/Mh	$12,20	$14.50/Day
A2	20.5gh/S	3900w	0.19j/Mh	$8,310	$13.51/Day
A3	18gh/S	3500w	0.19j/Mh	$7,899	$11.69/Day
A4	18.5gh/S	4250w	0.23j/Mh	$7,599	$10.44/Day
A5	17gh/S	3570w	0.21j/Mh	$4,800	$10.40/Day
A6	16gh/S	3360w	0.21j/Mh	$4,520	$9.79/Day
A7	16gh/S	3520w	0.22j/Mh	$4,888	$9.40/Day
A8	15gh/S	3150w	0.21j/Mh	$4,750	$9.18/Day
A9	20gh/S	6200w	0.31j/Mh	$7,400	$7.44/Day
A10	14.4gh/S	3950w	0.27j/Mh	$4,500	$6.59/Day

The Weights from Table 3, were converted into a matrix w = [0.3, 0.2, 0.1, 0.2, 0.2]. Furthermore, the alternatives in Table 4 are converted into matrix X, represented in Table 6.

Table 6. Matrix X

C1	C2	C3	C4	C5
33	9300	0.28	12200	**14.5**
20.5	3900	0.19	8310	13.51
18	3500	**0.19**	7899	11.69
18.5	4250	0.23	7599	10.44
17	3570	0.21	4800	10.4
16	3360	0.21	4520	9.79
16	3520	0.22	4888	9.4
15	**3150**	0.21	4750	9.18
20	6200	0.31	7400	7.44
14.4	3950	0.27	**4500**	6.59

Based on matrix X, the benefit and cost Rij are found as X = [33, 3150, 0.19, 4500, 14.5]. These figures are then used in normalization, the results of which are described in Table 7.

Table 7. Normalized Matrix X

C1	C2	C3	C4	C5
1.0000	0.3387	0.6786	0.3689	1.0000
0.6212	0.8077	1.0000	0.5415	0.9317
0.5455	0.9000	1.0000	0.5697	0.8062
0.5606	0.7412	0.8261	0.5922	0.7200
0.5152	0.8824	0.9048	0.9375	0.7172
0.4848	0.9375	0.9048	0.9956	0.6752
0.4848	0.8949	0.8636	0.9206	0.6483
0.4545	1.0000	0.9048	0.9474	0.6331
0.6061	0.5081	0.6129	0.6081	0.5131
0.4364	0.7975	0.7037	1.0000	0.4545

Matrix X then undergoes the calculation for the best alternative or Qi. To facilitate the calculation process, the author writes WSM and WPM separately. These 2 results are then combined to find the best alternative. The calculation results are described in Table 8, Table 9, and Table 10

Table 8. WSM Calculations

ID	**Calculations** (Si)	Results
A1	(0.3·1) + (0.2·0.3387) + (0.1·0.6786) + (0.2·0.3689) + (0.2·1)	**0.7094**
A2	(0.3·0.6212) + (0.2·0.8077) + (0.1·1) + (0.2·0.5415) + (0.2·0.9317)	**0.7426**
A3	(0.3·0.5455) + (0.2·0.9) + (0.1·1) + (0.2·0.5697) + (0.2·0.8062)	**0.7188**
A4	(0.3·0.5606) + (0.2·0.7412) + (0.1·0.8261) + (0.2·0.5922) + (0.2·0.72)	**0.6615**
A5	(0.3·0.5152) + (0.2·0.8824) + (0.1·0.9048) + (0.2·0.9375) + (0.2·0.7172)	**0.7524**
A6	(0.3·0.4848) + (0.2·0.9375) + (0.1·0.9048) + (0.2·0.9956) + (0.2·0.6752)	**0.7576**
A7	(0.3·0.4848) + (0.2·0.8949) + (0.1·0.8636) + (0.2·0.9206) + (0.2·0.6483)	**0.7246**
A8	(0.3·0.4545) + (0.2·1) + (0.1·0.9048) + (0.2·0.9474) + (0.2·0.6331)	**0.7429**
A9	(0.3·0.6061) + (0.2·0.5081) + (0.1·0.6129) + (0.2·0.6081) + (0.2·0.5131)	**0.5690**
A10	(0.3·0.4364) + (0.2·0.7975) + (0.1·0.7037) + (0.2·1) + (0.2·0.4545)	**0.6517**

Table 9. WPM Calculations

ID	**Calculations** (Pi)	Results
A1	$(1)^{0.3} . (0.3387)^{0.2} . (0.6786)^{0.1} . (0.3689)^{0.2} . (1)^{0.2}$	**0.6346**
A2	$(0.6212)^{0.3} . (0.8077)^{0.2} . (1)^{0.1} . (0.5415)^{0.2} . (0.9317)^{0.2}$	**0.7244**
A3	$(0.5455)^{0.3} . (0.9)^{0.2} . (1)^{0.1} . (0.5697)^{0.2} . (0.8062)^{0.2}$	**0.6987**
A4	$(0.5606)^{0.3} . (0.7412)^{0.2} . (0.8261)^{0.1} . (0.5922)^{0.2} . (0.72)^{0.2}$	**0.6550**
A5	$(0.5152)^{0.3} . (0.8824)^{0.2} . (0.9048)^{0.1} . (0.9375)^{0.2} . (0.7172)^{0.2}$	**0.7310**
A6	$(0.4848)^{0.3} . (0.9375)^{0.2} . (0.9048)^{0.1} . (0.9956)^{0.2} . (0.6752)^{0.2}$	**0.7265**
A7	$(0.4848)^{0.3} . (0.8949)^{0.2} . (0.8636)^{0.1} . (0.9206)^{0.2} . (0.6483)^{0.2}$	**0.6996**
A8	$(0.4545)^{0.3} . (1)^{0.2} . (0.9048)^{0.1} . (0.9474)^{0.2} . (0.6331)^{0.2}$	**0.7055**
A9	$(0.6061)^{0.3} . (0.5081)^{0.2} . (0.6129)^{0.1} . (0.6081)^{0.2} . (0.5131)^{0.2}$	**0.5669**
A10	$(0.4364)^{0.3} . (0.7975)^{0.2} . (0.7037)^{0.1} . (1)^{0.2} . (0.4545)^{0.2}$	**0.6145**

Table 10. WASPAS Calculations

ID	**Calculations** (Qi)	Results
Q1 (A1)	(0.5 · 0.7094) + (0.5 · 0.6346)	**0.672**
Q2 (A2)	(0.5 · 0.7426) + (0.5 · 0.7244)	**0.7335**
Q3 (A3)	(0.5 · 0.7188) + (0.5 · 0.6987)	**0.7088**
Q4 (A4)	(0.5 · 0.6615) + (0.5 · 0.655)	**0.6582**

ID	**Calculations** (Qi)	**Results**
Q5 (A5)	(0.5 · 0.7524) + (0.5 · 0.731)	**0.7417**
Q6 (A6)	(0.5 · 0.7576) + (0.5 · 0.7265)	**0.742**
Q7 (A7)	(0.5 · 0.7246) + (0.5 · 0.6996)	**0.7121**
Q8 (A8)	(0.5 · 0.7429) + (0.5 · 0.7055)	**0.7242**
Q9 (A9)	(0.5 · 0.5690) + (0.5 · 0.5669)	**0.5679**
Q10 (A10)	(0.5 · 0.6517) + (0.5 · 0.6145)	**0.6331**

Based on the calculation results above, the best alternative is found at Q6 or Bitmain Antminer L9 (16 GH/s). The position of Q1 or VolcMiner D1 Hydro at rank 7 shows that an ASIC with a high hashrate is not always the best choice when viewed against other variables [16]. Rank 3 or Q3 ElphaPex DG2+ shows that the highest power efficiency is not always the main factor in determining the best alternative. However, power efficiency becomes an important factor when a miner wants to use renewable energy to support the ASIC used [9]. The profitability criterion is a criterion that can change daily. Differences in electricity costs in each location can be a major factor in changing the ranking position. However, in this study, the electricity cost used is $0.1/kWh. See Table 11.

Table 11. Best Alternatives and Ranking

Alternatives	Qi	Ranking
Bitmain Antminer L9 (16 GH/s)	0.742	1
Bitmain Antminer L9 (17 GH/s)	0.7417	2
ElphaPex DG2+ (20.5 GH/s)	0.7335	3
Bitmain Antminer L9 (15 GH/s)	0.7242	4
ElphaPex DG2 (16 GH/s)	0.7121	5
VolcMiner D1 Pro (18 GH/s)	0.7088	6
VolcMiner D1 Hydro (33 GH/s)	0.672	7
VolcMiner D1 (18.5 GH/s)	0.6582	8
ElphaPex DG1+ (14.4GH/s)	0.6331	9
ElphaPex DG Hydro 1 (20GH/s)	0.5679	10

Based on the ranking results in Table 11, the Bitmain Antminer L9 (16 GH/s) obtained the highest preference value Qi=0.742. Conversely, the VolcMiner D1 Hydro, despite having the highest raw hashrate (33 GH/s), only ranked 7th (Qi=0.672). This finding aligns with the theory presented by Schinckus et al. [16], which states that an increase in hashrate is positively correlated with energy consumption penalties. Our results confirm that in a multi-criteria assessment, the advantage of hashrate held by VolcMiner is negated by its high power consumption and cost, making it less optimal compared to the Antminer L9 which offers a better balance between performance and efficiency. These findings offer a significant contribution by filling the gap in previous studies. While Xu and Cao and Srinivasan focused heavily on the architectural evolution and technical design of hardware [18], [19], this study proves that architectural superiority does not automatically equate to economic viability for miners. Unlike single-variable analyses that tend to prioritize speed linearly, the WASPAS implementation in this study successfully quantifies the trade-offs mentioned by Yazici et al. [9], demonstrating that energy efficiency is a more critical determinant for profitability ranking than raw speed in the Scrypt algorithm ecosystem

5. CONCLUSION

The increasing mining difficulty in the Scrypt algorithm ecosystem creates a complex decision-making environment where selecting the right ASIC is critical for profitability. This study addressed this challenge by implementing the WASPAS method to evaluate hardware performance against conflicting criteria such as hashrate, power consumption, and cost.

The primary contribution of this research is the provision of a systematic, measurable framework that allows miners to prioritize energy efficiency and economic viability over raw performance. Additionally, these insights serve as a reference for manufacturers regarding the shifting market preference towards sustainable and efficient hardware designs. However, this study is limited to ten ASIC models produced within the last two years and relies on static economic parameters, such as a fixed electricity cost of $0.1/kWh.

Consequently, future research should consider expanding the scope to include other mining and hashing algorithms like SHA-256, RandomX, Verushash. Furthermore, integrating dynamic data sources for real-time fluctuation analysis and conducting sensitivity analyses on criterion weights are recommended to enhance the adaptability and robustness of the decision-making model.

DAFTAR PUSTAKA

[1] M. M. W. Lasut, E. Y. Lumaing, A. Timomor, W. R. J. Lolong, and R. Simanjuntak, “Legal and Social Implications of Cryptocurrency: Adoption in Developing Countries,” *Technium Soc. Sci. J.*, vol. 65, p. 32, 2024.

[2] F. J. García-Corral, J. A. Cordero-García, J. de Pablo-Valenciano, and J. Uribe-Toril, “A bibliometric review of cryptocurrencies: how have they grown?,” *Financial Innovation*, vol. 8, 2022, doi: 10.1186/s40854-021-00306-5.

[3] D. Fantazzini and N. Kolodin, “Does the hashrate affect the bitcoin price?,” *Journal of Risk and Financial Management*, vol. 13, no. 11, p. 263, 2020.

[4] X. Yi, X. Yang, A. Kelarev, K. Y. Lam, and Z. Tari, “Cryptocurrencies,” in *Blockchain Foundations and Applications*, Springer, 2022, pp. 83–96.

[5] Coinwarz.com, “Litecoin Difficulty Chart - LTC Difficulty,” Coinwarz.com. Accessed: Jun. 22, 2025. [Online]. Available: https://www.coinwarz.com/mining/litecoin/difficulty-chart

[6] D. Watkins, “Scrypt mining with ASICS,” *arXiv preprint arXiv:2208.02160*, 2022.

[7] D. Stepanova, N. B. A. Yousif, R. Karlibaeva, and A. Mikhaylov, "Current analysis of cryptocurrency mining industry," *Journal of Infrastructure, Policy and Development*, vol. 8, no. 7, p. 4803, 2024.

[8] M. Muhammad, B. Waspodo, and Z. S. Nugraha, "Analyzing Frameworks for Green IT Adoption in Organizations: A Systematic Literature Review," *Jurnal Informasi Dan Teknologi*, pp. 107–113, 2025, doi: 10.60083/jidt.vi0.637.

[9] A. F. Yazici, A. B. Olcay, and G. A. Olcay, "A framework for maintaining sustainable energy use in Bitcoin mining through switching efficient mining hardware," *Technol Forecast Soc Change*, vol. 190, p. 122406, 2023.

[10] S. B. Pandya, H. A. Sanghvi, R. H. Patel, and A. S. Pandya, "Gpu and fpga based deployment of blockchain for cryptocurrency--a systematic review," in *2022 International Conference on Computational Intelligence and Sustainable Engineering Solutions (CISES)*, 2022, pp. 18–25.

[11] A. De Vries and C. Stoll, "Bitcoin's growing e-waste problem," *Resour Conserv Recycl*, vol. 175, p. 105901, 2021.

[12] A. Yaish and A. Zohar, "Pricing ASICs for cryptocurrency mining," *arXiv preprint arXiv:2002.11064*, 2020.

[13] M. A Muhammad, R. K Darmawan, A. Firgiawan, R. P Hikmahanto, and R. H Kusumaningtyas, "Analisis Kelayakan Investasi Saham Pada 5 Indeks Saham Syariah Indonesia (ISSI) Menggunakan Metode Waspas," *JATI (Jurnal Mahasiswa Teknik Informatika)*, vol. 9, no. 6, pp. 10514–10519, 2025, doi: 10.36040/jati.v9i6.16498.

[14] M. İşler and A. Çalık, "An approach to islamic investment decision making based on integrated Entropy and WASPAS methods," *Journal of Optimization & Decision Making*, vol. 1, no. 2, pp. 100–113, 2022, [Online]. Available: https://orcid.org/0000-0001-8858-9603

[15] A. Radomska-Zalas, "Application of the WASPAS method in a selected technological process," *Procedia Comput Sci*, vol. 225, pp. 177–187, 2023.

[16] C. Schinckus, C. P. Nguyen, and F. H. L. Chong, "Cryptocurrencies' hashrate and electricity consumption: evidence from mining activities," *Studies in Economics and Finance*, vol. 39, no. 3, pp. 524–546, 2022.

[17] B. Liang, "Design of ASIC accelerators for AI applications," in *IET Conference Proceedings CP895*, 2024, pp. 147–154.

[18] J. Xu, "Comparison and Application of FPGA and ASIC in Digital System Design," in *Proceedings of the International Conference on Decision Science \& Management*, 2024, pp. 216–220.

[19] D. Cao and V. Srinivasan, "Energy Efficient Hardware Design for Crypto Mining Algorithms," 2022.

[20] J. Khosa and A. Olanipekun, "Analyzing GPU Efficiency in Cryptocurrency Mining: A Comparative Study Using K-Means Clustering on Algorithm Performance Metrics," *Journal of Current Research in Blockchain*, vol. 2, no. 2, pp. 119–134, 2025.

[21] R. A. Rahman, M. C. Utami, and E. Fetrina, "Weighted Product dalam Sistem Pendukung Keputusan untuk Penentuan Mustahik," *Journal Applied Information Systems and Management (AISM)*, vol. 3, no. 01, pp. 1–6, 2021.

[22] R. G. U. A. Putra and A. W. Utami, "Decision Support System for Selecting Cryptocurrency Exchange Platforms Using the Multi Attribute Utility Theory (MAUT) Method Based on a Website," *Journal of Emerging Information System and Business Intelligence (JEISBI)*, vol. 5, no. 2, pp. 136–147, 2024.

[23] M. G. D. R. S. Meliala, F. Taufik, and E. F. Ginting, "Implementasi Metode WASPAS Dalam Menentukan Lokasi Strategis Pembukaan Branch Store Takoyaki," *Jurnal Sistem Informasi Triguna Dharma (JURSI TGD)*, vol. 3, no. 1, pp. 12–21, 2024.

[24] R. K. Purba, M. Mesran, and R. Syahputra, "Penerapan Metode WASPAS dengan Pembobotan ROC pada Pemilihan Duta Kampus di Universitas Budi Darma," *Jurnal Ilmiah Media Sisfo*, vol. 17, no. 2, pp. 212–227, 2023