

A Novel Hybrid Decision Making Framework for Comparing Market Performance of Metaverse Crypto Assets

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ABSTRACT

With proliferation of smartphone usage and rapidly increasing internet access, the financial sectors has been witnessing a transformational change in the last few years, leading to the digital economy. The cryptocurrencies (digital assets) and the metaverse assets that use blockchain technology extensively have emerged as an attractive investment option to the investors. The review of the extant literature shows a scantiness of research in comparing the performance of metaverse crypto assets based on market indicators. In this regard, the current work aims to provide a framework to compare the metaverse crypto assets based on their market performance. To this end, the present paper proposes a novel hybrid framework such as Logarithmic Percentage Change driven Compromise Solution based Appraisal (LOPCCSA). To compare the alternatives the variables like return, momentum of the daily closing price, market capitalization, trading volume and risk (in terms of historical volatility realized over the study period 2022). From the result we observe that the momentum of the closing prices and volatility of the price movements hold the higher importance as derived by calculation of objective weights. Theta Network (A10) comes out as the top performer ahead of ApeCoin (A1) or MANA (A3) or Internet Computer (A6). The comparison of the results obtained by LOPCCSA with other MCDM models show considerable consistency. The sensitivity analysis indicates that LOPCCSA provides a stable solution. The present paper is a distinct attempt that shall attract the decision makers and investors to carry out a deeper and comprehensive analysis of the metaverse crypto assets in near future.

1. Introduction

Metaverse in simple word is described as a “virtual universe”, a bonding of physical reality and virtual experience. Metaverse provides an online 3D seamless multiuser environment accessed and

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interacted through smart devices with technologies such as blockchain, AR, VR and artificial intelligence as its backbone. The conceptualization was evident dates back in 1982 when the novelist Neal Stephenson first coined the term in the celebrated novel "Snow Crash" although it gets large popularity and awareness with the change of the name of Facebook to Meta in 2021 [1-2]. Metaverse is one of top technologies featuring industry 4.0 and experts [3-4] believe that the stated technology promises to receive a significant investment and will bring revolutionary changes in the business environment in coming years. The recent pandemic has accelerated its growth.

In recent years there has been an increasing trading of metaverse assets. The metaverse assets are non-fungible tokens (NFT) with extensive use of blockchain technology. Metaverse possesses its own cryptocurrencies and financial transaction ecosystem. NFTs have been garnering interest of the financial markets since early 2021. NFTs are digital pure assets of unique/ "non-fungible" nature [5-6]. Metaverse form its own blockchain enabled digital asset economy, currencies, trade, and commerce [7-8]. The digital crypto assets in metaverse is classified into two forms such as coin (crypto asset with own blockchain) and token (traded on existing blockchains). The tokens are further divided into fungible and non-fungible categories [9]. However, most often tokens and coins are used simultaneously. The researchers observed that crypto assets can enable the investors/traders with better control over diversifiable risk and portfolio return even under extreme volatility and uncertainty imposed by price dynamics (like recent COVID-19) as compared with equity stock market [10].

There is some recent researches that worked on assessment of performance of metaverse tokens and coins. For instance, Vidal-Tomás [7] attempted to formulate a metaverse portfolio by analyzing the performance and dynamics of market price movements of 84 metaverse tokens and 129 play-to-earn tokens over a period between 28 October 2017 and 31 October 2021 and found positive performance though characterized by high volatility. Sahay et al. [1] investigated the effect of metaverse on the growth of business models. The authors utilized econometrics models such as ARIMA and SARIMAX to predict the stock prices of four Metaverse cryptocurrencies like AXS, MANA, SAND and ILV based on their performance during March 2021 to March 2022 and reported an increase in the investment. The study of [9] necessitated the need of examining the speculative nature of the price movements as the authors noted that the susceptibility of the price of a popular metaverse cryptocurrency like MANA to market speculation. Nakavachara and Saengchote [11] on the other hand put an effort to assess the utility of the metaverse tokens based on analysis of the transactions done by the users.

The review of the extant literature shows a scantiness of research in comparing the performance of metaverse crypto assets based on market indicators. In this regard, the current work aims to provide a framework to compare the metaverse crypto assets based on their market performance. Since the market performance depends on the values of a number of indicating variables the present work uses a MCDM approach. MCDM models allow the analyst to carry out a holistic comparative analysis of the alternative options considering their performance with respect to a number of diverse criteria [12-13]. The branch of MCDM methods namely multi-attribute decision making (MADM) intends to rank the alternative choices subject to influence of the criteria set to make a rational selection of the best possible option [14]. In this paper we propose a novel hybrid MADM framework. In recent years a new trend of hybridization of MCDM algorithms has been noticed. The researchers have been trying to combine the best features of two or more MCDM models to develop a new framework, for instance, compromise ranking of alternatives from distance to ideal solution (CRADIS) [15], preference ranking on the basis of ideal-average distance (PROBID) [16] and so on. The ongoing work makes an attempt to synthesize the advantages of two recently developed models such as Logarithmic Percentage Change-driven Objective Weighting (LOPCOW) [17] and combined

compromise solution (CoCoSo) [18] to propose a novel hybrid framework such as Logarithmic Percentage Change driven Compromise Solution based Appraisal (LOPCCSA). LOPCCSA provides the following advantages:

- Effective and efficient working with larger alternative and criteria set even with the presence of negative performance values in the decision matrix;
- Can provide a stable and reliable result. The proposed framework uses three distinct aggregation strategies to validate the ranking index;
- Provides the flexibility to the decision makers to set priority to the weighted power of the distance and multiplicative rule;
- Free from rank reversal phenomenon.

In summary, the major contribution of the current work is two-fold. First, the present work is apparently a rare work that extends the growing strand of literature by providing a multi-criteria-based performance evaluation of the metaverse crypto assets. Second, a novel hybrid MADM framework for complex decision making while compromising or trading off the effects of the criteria is proposed.

The remainder of the ongoing paper is constructed as follows. In section 2 a step-by-step brief description of the research design and methodological steps is provided. Section 3 highlights the major findings of the study. In section 4 a summary of the discussions on the findings is made. Section 5 provides the concluding remarks while in section 6 we exhibit some of the limitations of the present work and future scopes.

2. Materials and Method

In this section we briefly describe the research methodology.

2.1. Sample

In this paper we aim to compare 10 leading metaverse crypto assets (henceforth these will be the alternatives under comparison) based on their market performance. We consulted the reports published by NASDAQ [19] and Forbes [20] to select the leading metaverse crypto assets (listed in Table 1).

Table 1

List of metaverse crypto assets under comparison

S/L	Metaverse crypto asset
A1	ApeCoin (APE)
A2	Axie Infinity (AXS)
A3	Decentraland (MANA)
A4	Enjin Coin (ENJ)
A5	Highstreet (HIGH)
A6	Internet Computer (ICP)
A7	Metahero (HERO)
A8	Star Atlas (ATLAS)
A9	The Sandbox (SAND)
A10	Theta Network (THETA)

2.2. Criteria description

To compare the alternatives, we consider the following aspects like return, momentum of the daily closing price, market capitalization, trading volume and risk (in terms of historical volatility realized over the study period). The definitions of the criteria are given below:

C1. Average return: We consider daily return averaged over the trading days in the study period. The daily return on day t for i^{th} alternative is calculated as

$$R_{it} = \ln\left(\frac{cp_t}{cp_{t-1}}\right) \quad (1)$$

cp_t is the closing price of day t

C2. Average momentum: The momentum of i^{th} alternative on day t is derived as

$$M_{it} = cp_t - cp_{t-1} \quad (2)$$

Accordingly, we take the average of the daily momentums. This criterion is an indicator of the trending movements of the closing prices.

C3. Market capitalization: This is an indicative variable that reflects the worth of security (in terms of market value of the total outstanding shares) at the market place.

C4. Average volume: We take the daily traded volumes of transaction and average the same over the study period.

C5. Volatility: Volatility is the dispersion of the market return of a given security being traded during the given period. The standard deviation of the daily returns (σ) is calculated and the historical volatility for a given period of length T days is derived as

$$\vartheta = \sqrt{T} \sigma \quad (3)$$

The summary of the criteria and their nature is listed in Table 2.

Table 2

List of criteria

Criteria	UOM	Effect Direction
Average Return	Value	(+)
Average Momentum	USD	(+)
Market Cap	Billion USD	(+)
Average Volume	Billion	(+)
Volatility	Value	(-)

2.3. Data

The study period is selected as 2022. The data was collected from Yahoo Finance database and the decision matrix is formulated by deriving the performance values of the alternatives for the criteria (see Table 3).

Table 3

Decision matrix

Criteria/ Alternatives	C1	C2	C3	C4	C5
A1	-0.0044	-0.0324	1.8420	0.5539	1.3785
A2	-0.0075	-0.2418	1.1030	0.2412	1.1986
A3	-0.0067	-0.0084	1.1730	0.3167	1.1280

Criteria/ Alternatives	C1	C2	C3	C4	C5
A4	-0.0066	-0.0067	0.4618	0.1070	1.0493
A5	-0.0071	-0.0292	0.0872	0.0162	1.4042
A6	-0.0052	-0.0596	1.7210	0.1478	1.1108
A7	-0.0101	-0.0004	0.0250	0.0073	1.2388
A8	-0.0101	-0.0003	0.0338	0.0048	1.0209
A9	-0.0075	-0.0154	1.0290	0.4495	1.1001
A10	-0.0053	-0.0116	1.1560	0.1288	1.0839

2.4. Proposed Framework: LOPCCSA

As mentioned earlier, this is not a new method but is a new hybridization of the best features of LOPCOW and CoCoSo methods. The procedural steps are given below.

Let, $X = [x_{ij}]_{m \times n}$ represents the decision-matrix where, m is the number of alternative solutions and n is the number of criteria. The computational steps of LOPCCSA method are as follows.

Step 1. Normalization of the decision-matrix

Let, the normalized decision matrix is indicated as $V = [v_{ij}]_{m \times n}$

The normalization is done by using linear max-min scheme as given below

$$v_{ij} = \frac{x_{ij} - x_{j(\min)}}{x_{j(\max)} - x_{j(\min)}} \quad (\text{For the profit type criteria}) \quad (4)$$

$$v_{ij} = \frac{x_{j(\max)} - x_{ij}}{x_{j(\max)} - x_{j(\min)}} \quad (\text{For the cost type criteria}) \quad (5)$$

Step 2. Compute the Percentage Values (PV) of the alternatives

By using statistical fundamental concepts the PV scores are computed as

$$PV_j = \left| \ln \left(\frac{\sqrt{\frac{\sum_{i=1}^m v_{ij}^2}{m}}}{\sigma} \right) \cdot 100 \right| \quad (6)$$

σ : The standard deviation for the normalized values of the alternatives with respect to a particular criterion.

Step 3. Compute the criteria weights

The weight for the j^{th} criterion is calculated by using proportional contributions as given below:

$$w_j = \frac{PV_j}{\sum_{j=1}^n PV_j} \quad (7)$$

where,

$$\sum_{j=1}^n w_j = 1$$

Step 4. Computation of the sum of the power weighted and weighted normalized values

The sum of weighted normalized values is computed as:

$$S_i = \sum_{j=1}^n w_j v_{ij} \quad (8)$$

The sum of power weighted normalized values are obtained using the multiplicative concepts applied in WASPAS approach. The sum is expressed as:

$$P_i = \sum_{j=1}^n (v_{ij})^{w_j} \quad (9)$$

Step 5. Computation of the relative weights of the alternative solutions using aggregations

Three aggregation strategies are applied using arithmetic average, proportional comparison with respect to the benchmark solution and balanced compromise of the sum of power weighted and weighted normalized values. Accordingly, the aggregated scores of the alternatives are given below

$$\Phi_{i(a)} = \frac{P_i + S_i}{\sum_{i=1}^m P_i + S_i} \quad (10)$$

$$\Phi_{i(b)} = \frac{S_i}{\text{Min } S_i} + \frac{P_i}{\text{Min } P_i} \quad (11)$$

$$\Phi_{i(c)} = \frac{\lambda S_i + (1-\lambda)P_i}{(\lambda \text{Max } S_i + (1-\lambda)\text{Max } P_i)}; 0 \leq \lambda \leq 1 \quad (12)$$

The variable λ provides the flexibility to the decision-makers. For calculation purpose, the authors (for instance, [18], [21]) have treated the value of λ as 0.5.

Step 6. Calculation of the final appraisal scores

The final appraisal scores are calculated as

$$\Phi_i = (\Phi_{i(a)} \Phi_{i(b)} \Phi_{i(c)})^{\frac{1}{3}} + \frac{1}{3} (\Phi_{i(a)} + \Phi_{i(b)} + \Phi_{i(c)}) \quad (13)$$

Decision rule: Higher is the appraisal score, better is the corresponding alternative.

3. Results

In this section we summarize the findings. In what follows is the step-by-step presentation of the results. First, the normalization of the performance values as given in Table 3 are done by using the expressions (4) and (5). Table 4 provides the normalized decision matrix.

Examples of calculation:

$$v_{13} = \frac{x_{13} - x_{3(\min)}}{x_{3(\max)} - x_{3(\min)}} = \frac{1.842 - 0.025}{1.842 - 0.025} = 1.000$$

$$v_{25} = \frac{x_{5(\max)} - x_{25}}{x_{5(\max)} - x_{5(\min)}} = \frac{1.404 - 1.199}{1.404 - 1.021} = 0.5363$$

Table 4

Normalized decision matrix

Alternative	Criteria				
	C1	C2	C3	C4	C5
A1	1.0000	0.8671	1.0000	1.0000	0.0671
A2	0.4479	0.0000	0.5933	0.4306	0.5363
A3	0.6047	0.9665	0.6318	0.5680	0.7205
A4	0.6094	0.9733	0.2404	0.1862	0.9257
A5	0.5343	0.8803	0.0342	0.0209	0.0000
A6	0.8696	0.7543	0.9334	0.2605	0.7654
A7	0.0010	0.9997	0.0000	0.0046	0.4316
A8	0.0000	1.0000	0.0048	0.0000	1.0000
A9	0.4469	0.9376	0.5526	0.8100	0.7932
A10	0.8455	0.9531	0.6225	0.2259	0.8357

Using the normalized decision matrix and applying expressions (6) and (7) the criteria weights are calculated (given in table 5).

Example of calculation

$$PV_5 = \ln \left(\frac{\sqrt{\frac{\sum_{i=1}^{10} v_{i5}^2}{10}}}{\sigma} \right) \cdot 100 = 69.1314$$

$$w_5 = \frac{PV_5}{\sum_{j=1}^5 PV_j} = \frac{69.1314}{61.6274 + 107.0065 + 44.5330 + 32.5302 + 69.1314} = 0.2196$$

Table 5

Calculation of the criteria weights

	C1	C2	C3	C4	C5
Mean Square	0.3894	0.7764	0.3374	0.2318	0.4768
SD	0.3369	0.3022	0.3721	0.3478	0.3459
PV	61.6274	107.0065	44.5330	32.5302	69.1314
Wj	0.1957	0.3399	0.1415	0.1033	0.2196

It is seen that C2 and C5 have obtained the higher weights. During the study period the momentum and risk are given priorities. Metaverse crypto assets depend on the traders' behaviours and sentiment. Furthermore, cryptocurrencies are more susceptible to market risk. Hence, the findings of criteria weights are logical. We move further to find out the relative rankings of the alternatives using the expressions (8) to (13). Table 6 provides the final calculations and rankings.

Table 6

Ranking of the alternatives

	P_i	S_i	P_i+S_i	$\Phi_{i(a)}$	$\Phi_{i(b)}$	$\Phi_{i(c)}$	Φ_i	Rank
A1	4.5052	0.7500	5.2552	0.1145	4.0703	0.9572	2.4782	5
A2	3.5721	0.3338	3.9059	0.0851	2.4461	0.7115	1.6100	7
A3	4.7056	0.7532	5.4588	0.1190	4.1610	0.9943	2.5476	2
A4	4.5396	0.7066	5.2463	0.1143	3.9545	0.9556	2.4308	6
A5	3.1330	0.4108	3.5438	0.0772	2.4988	0.6455	1.5733	8
A6	4.6852	0.7536	5.4388	0.1185	4.1542	0.9907	2.5416	3
A7	2.6612	0.4352	3.0965	0.0675	2.3810	0.5640	1.4533	10
A8	2.4701	0.5602	3.0303	0.0660	2.6779	0.5520	1.5591	9
A9	4.6809	0.7422	5.4231	0.1182	4.1182	0.9878	2.5248	4
A10	4.7055	0.7844	5.4899	0.1196	4.2544	1.0000	2.5898	1

Examples of calculation

$$S_3 = \sum_{j=1}^5 w_j v_{3j} = w_1 v_{31} + w_2 v_{32} + \dots + w_5 v_{35} = 0.1184 + 0.3285 + \dots + 0.1582 = 0.7532$$

$$P_3 = \sum_{j=1}^5 (v_{3j})^{w_j} = (v_{31})^{w_1} + (v_{32})^{w_2} + \dots + (v_{35})^{w_5} = (0.6047)^{0.1957} + (0.9665)^{0.3399} + \dots + (0.7205)^{0.2196}$$

$$= 0.9062 + 0.9885 + \dots + 0.9306 = 4.7056$$

$$\Phi_{3(a)} = \frac{P_3 + S_3}{\sum_{i=1}^{10} P_i + S_i} = \frac{5.4588}{5.2552 + 3.9059 + \dots + 5.4899} = 0.1190$$

$$\Phi_{3(b)} = \frac{S_3}{\min S_i} + \frac{P_3}{\min P_i}; (i = 1, 2, \dots, 10) = \frac{0.7532}{0.3388} + \frac{4.7056}{2.4701} = 4.1610$$

$$\Phi_{3(c)} = \frac{\lambda S_i + (1-\lambda)P_3}{(\lambda \max S_i + (1-\lambda)\max P_i)}; 0 \leq \lambda \leq 1; i = 1, 2, \dots, 10 = \frac{0.5(0.7532) + (1-0.5)4.7056}{0.5(0.7844) + (1-0.5)4.7056} = 0.9943$$

$$(\lambda = 0.5)$$

$$\Phi_3 = (\Phi_{3(a)} \Phi_{3(b)} \Phi_{3(c)})^{\frac{1}{3}} + \frac{1}{3} (\Phi_{3(a)} + \Phi_{3(b)} + \Phi_{3(c)})$$

$$= (0.1190 \times 4.1610 \times 0.9943)^{\frac{1}{3}} + \frac{1}{3} (0.1190 + 4.1610 + 0.9943) = 2.5476$$

3.1. Comparison with other MCDM Models

Reliability of the outcome of MCDM based analysis is of interest to the decision makers. MCDM results depend on underlying assumptions and nature of the model and given conditions such as size of the criteria and alternative set and their nature, changes in the criteria weights and so on [22]. Therefore, it is necessary to check the reliability of the result. The extant literature (for instance [23-

24]) demonstrated the comparison of the result obtained by a given MCDM model with the same derived by applying other models. In the present work the ranking obtained by using our proposed LOPCCSA model is compared with that derived by using some of the recent and popular models such as Proximity Indexed Value (PIV) [25], CRADIS [15] and Multi-Attributive Border Approximation area Comparison (MABAC) [26]. We perform Spearman's rank correlation (SRC) coefficients to examine the consistency among the rankings obtained by using various models (see Table 7). It is noticed that LOPCCSA maintains significant correlation with other models. Therefore, we can conclude that LOPCCSA provides considerably reliable results.

Table 7

Comparison of results of MCDM models

		PIV	CRADIS	MABAC
LOPCCSA	Spearman's rho	.685*	.907**	.867**
	Sig. (2-tailed)	0.029	0.00	0.001

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

3.2. Sensitivity Analysis

Stability of the result attained by using MCDM models is of notable interest to the analysts. The stability gets violated with the changes in the given conditions. We perform a multi-phased sensitivity analysis (SA) in line with the past evidence (for example, [27], [28]). The schemes for performing SA are given in Tables 8 and 9.

Table 8

Sensitivity analysis – Scheme A

Cases	Original	Exp A1	Exp A2	Exp A3	Exp A4	Exp A5	Exp A6	Exp A7	Exp A8
λ	0.5	0.6	0.7	0.8	0.9	0.4	0.3	0.2	0.1

In scheme A, we change the values of λ from 0.1 to 0.9 (including the original value = 0.5 used for analysis) (see Table 8) and obtain the ranking of the alternatives. Figure 1 reflects that A8 and A2 show minor variations while others retain their relative positions. Hence, it may be inferred that given the allowable flexibility to the decision maker about his/her emphasis on aggregation strategies the original ranking provided by LOPCCSA does not vary notably and maintains stability.

Table 9

Sensitivity analysis – Scheme B

Cases	Criteria Weights				
	C1	C2	C3	C4	C5
Original	0.1957	0.3399	0.1415	0.1033	0.2196
Exp B1	0.2042	0.3059	0.1499	0.1118	0.2281
Exp B2	0.2127	0.2719	0.1584	0.1203	0.2366
Exp B3	0.2212	0.2379	0.1669	0.1288	0.2451
Exp B4	0.2297	0.2039	0.1754	0.1373	0.2536
Exp B5	0.2382	0.1699	0.1839	0.1458	0.2621
Exp B6	0.2467	0.1360	0.1924	0.1543	0.2706
Exp B7	0.2552	0.1020	0.2009	0.1628	0.2791
Exp B8	0.2637	0.0680	0.2094	0.1713	0.2876
Exp B9	0.2722	0.0340	0.2179	0.1798	0.2961

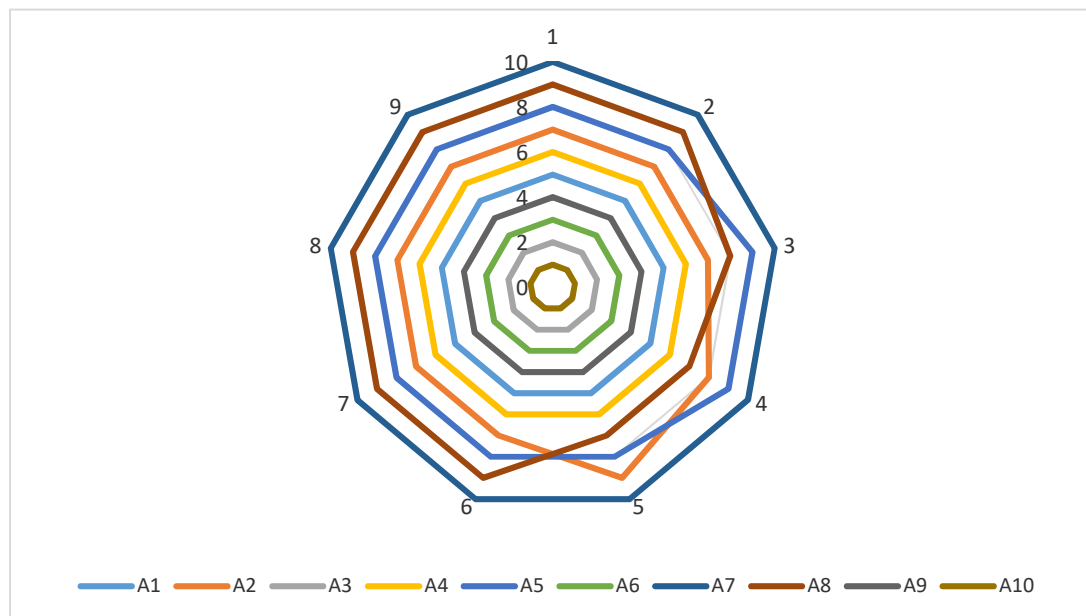


Fig. 1. Result of SA (scheme A)

In the similar way we find the ranking of the alternatives and plot graphically (see Figure 2). Figure 2 shows a slightly more variation in case of scheme B than scheme A. However, the variation is not significantly high.

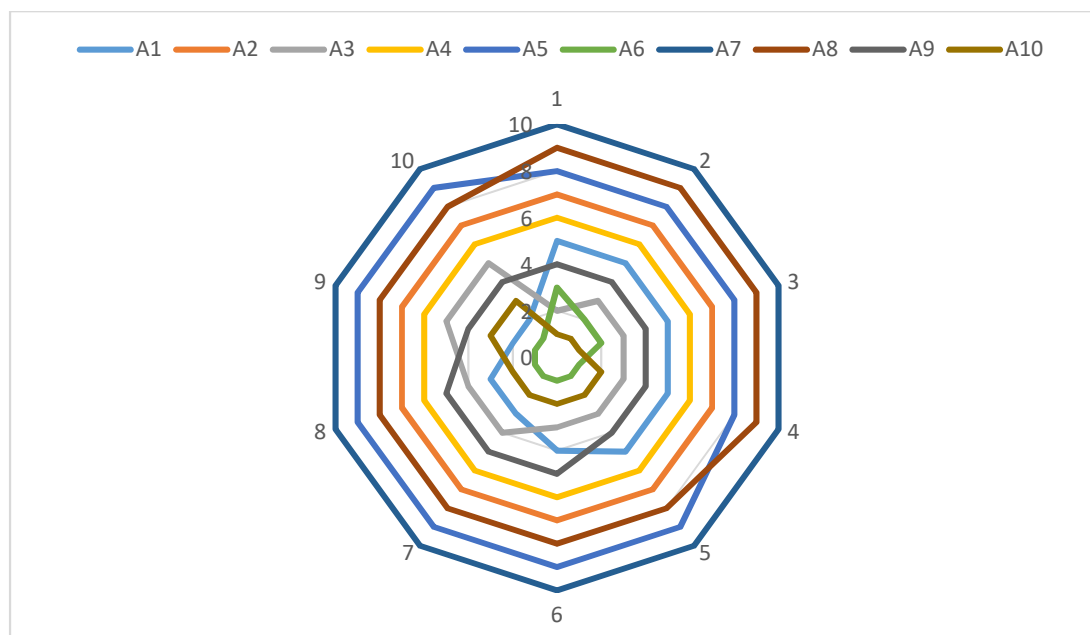


Fig. 2. Result of SA (scheme B)

Therefore, we conclude that LOPCCSA provides a considerably stable outcome as is evident from its performance through SA by changing two underlying conditions.

4. Discussions

From the result we observe that the momentum of the closing prices and volatility of the price movements hold the higher importance as derived by calculation of objective weights. The result contradicts the observations made by Arias-Oliva et al. [29] wherein the authors did not find risk as an important aspect to the investors dealing with cryptocurrencies. However, there are some other past studies on crypto assets that resemble the findings of the present work. For example, Büyükaslan and Ecer [30] found that among financial factors return is the most important one closely followed by risk and price movements. In this regard, our work is supported as we notice that price movement, volatility (risk) and return are the top three criteria based on their weights. The researchers [30] also noted that risk and return being highly considered by the investors for speculative purpose, security is the most important consideration of the investors. In [31] and [32] the authors compared two popular cryptocurrencies primarily focusing on their price movements. Therefore, the findings that momentum is of higher priority is not a contradiction to the past studies.

We note that popularity does not necessarily get reflected in the market performance at risk-return interface since Theta Network (A10) comes out as the top performer ahead of ApeCoin (A1) or MANA (A3) or Internet Computer (A6). We also have ranked the alternatives based on their performances on each dimension (i.e., based on each criterion) separately and tried to figure out the association among the performances subject to individual criterion and overall ranking. We observe that performance based on market cap and average return maintain consistency with the overall ranking. This is an interesting but apparently unexpected finding. It suggests that the movement of closing prices and volatility mark the difference among the market performances of the metaverse crypto assets. It is also an apparent indication that performance of the metaverse crypto assets is subject to short term variations.

Given the comparability of the results obtained by our model with various other MCDM methods indicates the reliability of LOPCCSA while the outcome of the sensitivity analysis confirms its stability. However, the model has a limitation. If any of the aggregated scores become zero or if there is a high

difference in values of the individual aggregated scores, then the final appraisal score may not reveal the true picture. Further, the formation of decision matrix does not include the ideal and anti-ideal solutions.

5. Conclusion

The present paper has presented a novel MCDM framework such as LOPCCSA to compare the market performance of 10 leading metaverse crypto assets. The LOPCCSA model takes the advantage of rationalization of the criteria weights (by combating the abrupt distribution of the weights) and efficiency in dealing with negative performance values while generate a compromise solution with three different aggregation strategies. We have used the indicators like return, momentum of the daily closing price, market capitalization, trading volume and risk (in terms of historical volatility realized over the study period) for comparing the alternatives based on their performance in 2022. We have observed that momentum and risk obtain higher weights. It is seen that Theta Network followed by Decentraland (MANA) and Internet Computer hold the top three positions while Metahero, Star Atlas and Highstreet remain in the bottom performer group. We contend that the market performance of the metaverse crypto assets are influenced by short run variations in the closing price and volatility of the returns as the investors want to maximize their gains in short term. We have performed the sensitivity analysis and compared LOPCCSA with other MCDM models. It is observed that our model provides a considerably reliable and stable solution. The present paper is a distinct attempt that shall attract the decision makers and investors to carry out a deeper and comprehensive analysis of the metaverse crypto assets in near future.

6. Limitation and Future Scope

The present study has several future scopes. Firstly, the ongoing work is limited to assessment of market performance based on five indicator variables which may be further extended. Secondly, the metaverse crypto assets may be compared based on investors' opinions since the extant literature argued that investment in the cryptocurrencies largely depends on investors' sentiments. Thirdly, the metaverse assets consume energy. Hence, a future study may compare the crypto assets based on sustainability indicators. Fourth, a multi-period comparative analysis of metaverse crypto assets with conventional securities can be carried out. Fifth, from a methodological point of view LOPCCSA may be applied to other complex real-life issues with uncertain information.

Conflicts of Interest

The authors declare no conflicts of interest.

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