Blockchain knowledge selection under the trapezoidal fermatean fuzzy number

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Abstract
Blockchain knowledge signifies a useful fundamental knowledge to safeguard faith in transboundary transmittals for main banks and financial institutions. In the study of group decision-making, the most important issue is how to coordinate opinions from different blockchains to reach a compromise under uncertainty. To tackle uncertainties surrounding multi-attribute group decision-making (MAGDM) problems in real-life scenes, we introduce a trapezoidal fermatean fuzzy set which generalizes trapezoidal fuzzy sets and fermatean fuzzy sets. The trapezoidal fermatean fuzzy model enables the degrees of membership, abstention, and non-membership to be expressed by linguistic terms. We define the operational laws of trapezoidal fermatean fuzzy numbers, and Einstein aggregation operator based on the trapezoidal fermatean fuzzy number. This makes it more flexible and descriptive to model the attitudes of Blockchain knowledge in MAGDM applications. Since multi-input arguments are interconnected and Blockchain knowledge has a lot of options perception, we also define the TOPSIS technique to facilitate the fusion of trapezoidal fermatean fuzzy information. With the aid of the trapezoidal fermatean fuzzy-TOPSIS technique, the main goal of this research is to present a general MAGDM framework by integrating the step with the complex proportional assessment. A trapezoidal fermatean positive ideal solution always wants the maximum value of the benefit criteria and the minimum value of the cost criteria. On the other hand, the trapezoidal fermatean negative ideal solution always wants the maximum value of the cost criteria and the minimum value of the benefit criteria. An integrated trapezoidal fermatean fuzzy-TOPSIS framework is established. In the proposed decision framework, the trapezoidal fermatean fuzzy-TOPSIS method is utilized to identify the subjective weights of decision attributes, and the trapezoidal fermatean fuzzy-TOPSIS approach is used to rank alternatives. Lastly, a case study concerning blockchain knowledge assessment is presented to demonstrate that the suggested scheme is feasible and effective. Furthermore, sensitivity and comparison analyses are conducted to show the robustness and superiority of the proposed method.

Keywords Blockchain knowledge · Trapezoidal fuzzy set · Aggregation operators · Multi-attribute decision making · Trapezoidal fermatean fuzzy TOPSIS technique

1 Introduction
Since the advent of Bitcoin in 2008, the indispensable folder plan of a blockchain has conventional wide care (Gupta 2017). A blockchain is a circulated archive skill that contains the greatest data consecutively on peer-to-peer systems. Since separately contributors can admittance the complete catalog and important annals (Chen 2018), the dealings container be preserved by a collection of bulges, and thus, a reliable third gathering can be eradicated when standards change (Beck and Muller-Bloch 2017; Birch et al. 2016; Lin et al. 2017). Moreover, as the
dispersed archive is of extraordinary clearness, sanctity, immutability, and decentralization, the blockchain has been practicing in the areas of finances, medication, Internet of Belongings (Li et al. 2017), and reproduction intellect (Zhang et al. 2021), for requests such as economic dealings (Wang et al. 2019; Varma 2019), fitness overhaul data organization (Yaqoob et al. 2021), source cable organization (Liu et al. 2019), and management actions such as translucent elective and numerical autographs. Using this system, one can produce truthful alphanumeric chronicles translucent elective and numerical autographs. Using this system, one can produce truthful alphanumeric chronicles. Vitality may be a significant calculate for the maintainable development of the nations.

An object from Harvard Commercial Appraisal declared that a blockchain prepared to set and law companies what the Internet fixed to television (Ito et al. 2017). The monetary facility arena develops an innovator in the examination of substructures and commercial replicas based on blockchains (Beck and Müller-Bloch 2017), and frequent main sets and fiscal organizations have assumed blockchain skill in doings, such as defrayal and defrayal, cross-border payment, numerical promoting, source chain economics, recognition journalism, user individuality confirmation and explanation sympathy (Beck et al. 2016). In addition, numerous blockchain startups have industrialized blockchain technology explanations for doings in major sets and economic organizations. In this situation, the difficulty of the assortment of a fitting blockchain skill provider by a major bank or financial organization, based on several criteria, has appeared. Owing to the intricacy of blockchain technology, which comprises inconsistent and discordant criteria such as the rate and speediness, effectiveness and risk, and deficient perception and understanding of the specific decision-maker, blockchain skill provider variety for chief sets is observed as definitive multi-criteria group decision-making problematic.

Because of the complicity of blockchain skill and inadequate data and involvement of the DMs, the criteria or substitutes frequently cannot be assessed as finished crisp values. Zadeh (1965) started the fuzzy set principle by applying the membership degree to define indecision. Then, many delays were industrialized. Turkensen (1986) protracted this method to an interval-valued fuzzy set that portrayed the membership degree. Atanassov (1986) and Atanassov and Gargov (1989) presented an intuitionistic fuzzy set and an interval-valued intuitionistic fuzzy (IVIF) set, which detained an idea of the nonmembership grade and satisfied the resultant complaint: the synopsis of membership and nonmembership gradations is not developed than 1.

Zhou and Chen (2021) revolutionized fact workers to designate members’ risk favorites concerning a blockchain and then prejudiced succeeding rudiments indoors the decision matrix. However, the damage boldness level dislikes animatedly reproduced the DM’s thinking in the current methods and the DMs’ mental alteration concerning the blockchain program.

Aslam et al. (2022) presented concurrent access control and monitoring of ERP, private permissioned Blockchain using Proof of Elapsed Time consensus is more suitable. The study also investigated the bottleneck issue of transaction processing rates (TPR) of Blockchain consensus, specifically ERP’s TPR. Alam et al. (2022) introduced the finally comes up with various implementation requirements in Government, Health, Finance, Economics, and Energy. Qahtan et al. (2022) introduced employed to benchmark blockchain-based IoT healthcare Industry 4.0 systems through the combined gray relational analysis technique for order of preference by similarity to ideal solution (GRA-TOPSIS) and the bald eagle search (BES) optimization method.

Shuaib et al. (2022a) presented avoiding conflict and to support Environmental Sustainability. These traditional land registry applications also lack identity parameters due to weaknesses in identity solutions. A secure and reliable digital identity solution is the need of the hour. Self-sovereign identity (SSI), a new concept, is becoming more popular as a secure and reliable identity solution for users based on identity principles. SSI provides users with a way to control their personal information and consent for it to be used in various ways. In addition, the user’s identity details are stored in a decentralized manner, which helps to overcome the problems with digital identity solutions. Shuaib et al. (2022b) presented a design to overcome these limitations and provide a secure, reliable, and efficient identity solution that gives complete control to the users over their personal identity information. Shuaib et al. (2022c) presented examined the current land registry model and its shortcomings. It explains the various blockchain types and their characteristics. It further evaluates the usability of blockchain technology in different aspects of the land registry. Identity management is one of such weaknesses in the blockchain-based land registry model that has been assessed in detail. Identity issues of blockchain-based models have been further evaluated on defined criteria. Rahmani et al. (2022) presented the centralization, huge overhead, trust evidence, less adaptive, and inaccuracy. This systematic review has been performed.
in six stages: identifying the research question, research methods, screening the related articles, abstract and keyword examination, data retrieval, and mapping processing. Atlas, the software is used to analyze the relevant articles based on keywords. A total of 70 codes and 262 quotations are compiled, and furthermore, these quotations are categorized using manual coding. Bhatia et al. (2022) introduced to train end-to-end segmentation of pixels into vessel and background classes.

This technique reflects both the impartial valuations regarding the consistent criteria and the individual risk outlooks concerning blockchain skills. We describe a set of criteria to lengthily degree the blockchain technology benefactors’ performance regarding the cross-border transmittal for chief sets in contract with the available works and stunning topographies of blockchain skill. We assume the TOPSIS, which can precisely define the uncertainty and misgivings in rulings due to insufficient assumption and participation related to the blockchain, to acquire the criterion weights with TrFF data. We adventure the TrFF TOPSIS technique to discover the comprehensive sovereignty grade for each claimant, and dynamic the candidates in reducing order seeing the DM’s risk desire concerning a blockchain by conclusive the decrease issue of the offended. We appliance compassion training by changing the lessening factor arithmetic value and secondary the consequences with individuals got using the contemporary TrFFPIS and TrFFNIS technique to authenticate its success and suitability of our obtainable mixture method.

The rest of the paper is summarized in Sect. 2, which we offer about the properties of fundamental ideas. Section 3, we exhibit of TrFPNs and operational laws. Section 4, we define the MCDM based on the TrFF TOPSIS technique. Section 5, the request for the developed technique in GDM is a visible example. Section 6, we considered comparative analysis. Finally, a material conclusion is certain in Sect. 7.

1.1 Literature review

This section concisely appraisalas the standards and methods for measuring blockchain technologies, stages, crops, and suppliers. This places the basis to create the criteria to choose the suitable blockchain technology supplier for main sets or financial organizations which means relating blockchain skills throughout the procedure of cross-border transmittal.

A blockchain is a type that consists of a growing list of records, called blocks, that are securely linked together using cryptography. Each block contains a cryptographic hash of the previous block, a timestamp, and transaction data (generally represented as a Merkle tree, where data nodes are represented by leaves). The timestamp proves that the transaction data existed when the block was created. Since each block contains information about the block before it, they effectively form a chain (compare linked list data structure), with each additional block linking to the ones before it. Consequently, blockchain transactions are irreversible in that, once they are recorded, the data in any given block cannot be altered retroactively without altering all subsequent blocks.

However, many researchers (50, 51) employed in the arena of smearing digital individuality explanations for blockchain-based property archive schemes inveterate the subject of noncompliance with numerical identity values. So though emerging a unique explanation for a blockchain-based land archive organization, these subjects need attention (52, 53).

Blockchains are typically managed by a computer network for use as a public distributed ledger, where nodes collectively adhere to a consensus algorithm protocol to add and validate new transaction blocks. Although blockchain records are not unalterable, since blockchain forks are possible, blockchains may be considered secure by design and exemplify a distributed computing system with high Byzantine fault tolerance.

Owed to the existence of developing technology, a methodical evaluative criteria scheme for the presentation assessment of blockchain skill suppliers has not been recognized, though academics have browbeaten sure standards to assess blockchain technologies, crops, or facilities. Tang et al. (2019) invented a usual assessment schemeing 3 main criteria and 11 sub-club-criteria selected schemes for a suitable community blockchain, in which skill, credit, and applied action remained the key issues. Özkan et al. (2019) created a usual assessment to assess the blockchain skill risk. The safety matter was the greatest dangerous risk at the primary equal, and cyberattacks, confidentiality subjects, and exercise prices were the greatest dangerous dangers at the extra equal. Jin et al. (2019) assessed sustainable blockchain skills, seeing the price, generation, concert, and after-sales facility. Farshidi et al. (2020) obtained an order of standards, counting functionality, flexibility, and compatibility with obtainable software foodstuffs, to choose a blockchain stage. Colak et al. (2020) offered a multi-criteria evaluative style to measure blockchain skills used in a stock hawser system. Yoon et al. (2020) struggled to discover the issues manipulating the alteration of blockchain technology inside the nautical logistics arena and recognized pertinent alteration variables in footings of ecological, structural, economic, and practical issues. Ozdemir et al. (2019) proposed rudimentary criteria to measure a blockchain request in tourism, which comprised the blockchain supremacy form, stages, agreement kind, operation of cryptocurrency, keen agreements, and marks.
As designated in Table 1, price (85.71%), ability (78.57%), creation and facility excellence (64.29%), and safety (64.29%) exhibit high rank. Though, binary limits are originating in the existing criteria for blockchain agendas. Pertinent danger issues are not devoted to rank in existing poetry. Meanwhile, cross-border payment is an important procedure in financial organizations, the supplies for speed, care, and correctness are severe. Blockchain founded on confusion processes and encryption skills can protect the safety of the transmittal. However, the whole staff must contribute to the control to attain an agreement, which leads to little competence and a minor amount of dealings per additional (Tang et al. 2019). Hence, it is crucial to exploit the assessment of blockchain suppliers, seeing the high presentation and little apparent danger. Care and jeopardy switch are binary features of one driver, so we container shape the chief criteria called refuge risk. Technological equality, creation and facility excellence, fiscal issues, and safety danger are stared as the chief criteria and a crucial essential to finding pertinent sub-criteria to measure the presentation of blockchain skill suppliers relating to the available criteria and exclusive features of cross-border transmittals in financial establishments. From this assessment, this item proposes to shape graded evaluative criteria for chief series or economic foundations that propose to relate blockchain technology in cross-border settlement slog. The criteria for the scientific smooth can be divided into fundamental skill, scalability, interoperability, and dispensation rapidity. The criteria for the creation and facility excellence can be divided into the generation of the creation, rudimentary facility, after deals facility, and additional service. The fiscal influence can be segmented into Table 1.

First, incomplete devices use fuzzy data to measure blockchain presentation. Among the current works regarding blockchain knowledge valuation, Çolak et al. (2020), Bai and Sarkis (2020), and Karaşan et al. (2021) used hesitant fuzzy data. Owing to the absence of information and skills concerning blockchain skills, rulings relating to the criteria might not be precise, and the crisp numbers might not exactly reflect the DMs’ rulings (Tables 2, 3, 4, 5, 6 and 7).

1.2 Novelties

In this article, we mark an effort to integrate and speech the following ideas:

i. To describe innovative operational law for trapezoidal fermatean fuzzy data which is a valuable complement of standing operational law and examined their arithmetical possessions.

ii. To present new operators like trapezoidal fermatean fuzzy data fuzzy aggregation operators.

iii. Proposition of MCGDM strategy in TrFF environment.

iv. To demonstrate the proposed method, we solved a numerical problem based on a real-life problem.

v. A sensitivity analysis is performed to show the utility and efficiency of the designed method.

1.3 Contributions and structure

This research has contributed to the exploration of MAGDM under uncertainty in the following aspects:

- The TrFF is introdTFS as a new generalization in TrFS theory to tackle the complexities in numerical data by combing the TrFN terms and FFN.
- The TrFFE operator, TrFF TOPSIS technique are proposed by the integration MAGDM.
A MAGDM innovation for blockchain assessment in TrFF based on the TrFF TOPSIS technique is established.

An assessment framework of the blockchain selection scheme using the proposed MAGDM innovation is constructed.

The essential innovations of this object associated with the current blockchain evaluative standards and approaches container be drawn as surveys:

- A sequence of regular standards is created to choose the appropriate blockchain skill supplier for main sets or financial organizations, which can contribute to the DMs smearing the blockchain to the cross-border transmittal action.
- The TrFF sets are practical in the presentation assessment of the blockchain skill workers, which can reproduce additional unstated and clear rulings and favorites of the DMs and exhibition a better scope compared to the additional trapezoidal formation fuzzy sets to precisely get the decision-making marks.
- TrFF TOPSIS technique is applied to evaluate the blockchain skill workers sighted the DMs’ risk favorite completed the blockchain skill and seeing the decrease limit near damage, which things the supremacy results of one additional, and to precisely get the best supplier.
- A TrFF TOPSIS technique is recognized to language MCGDM problems and delivers an arranged and reliable program to language blockchain skill supplier variety problems.

### 1.4 Motivation

i. TrFFSs in TOPSIS (with MCDM concept) have been implemented in a real-life blockchain assessment problem for manufacturing in the literature.

Considering the blockchain width, this study will lead future studies in this field.

ii. For TrFF-TOPSIS computations, a new linguistic scale under Fermatean fuzzy documentation has also been developed for experts to disclose their judgments easily. The scope of information uncertainty covered by trapezoidal Fermatean fuzzy is broader than that of conventional trapezoidal fuzzy number, and Fermatean fuzzy number, which is instrumental in avoiding potential information missed in qualitative conversion to quantification. Scholars may benefit from this scale in future studies. In addition, TrFF-TOPSIS uses PIS and NIS as reference points for distance calculation, which can obtain more potential information.

iii. Practitioners in the industry can adapt the case application presented in this study for their risk assessment processes. From this point, good practice is demonstrated with detailed steps from expert judgments to risk preventive measure suggestions.

iv. A comparative analysis is provided to test the solidity of the proposed approach. To do this, crisp, intuitionistic fuzzy, and FFs are applied to the problem. Analysis results are not exactly the same as TrFF-TOPSIS. Since the TrFFs measure both the membership and non-membership, but crisp, fuzzy, and gray theories only consider the membership.

To initiate with of all, there are frequent considers within the script on source cable management. Predominantly in advanced an extended time, susceptibility in decisions-making procedures for as well as many criteria has extended. This condition completes a feasible decision-making grip certainly more worrying. Then, there’s a mounting necessity for additional complete study plans for this make. In other arguments, seeing MCDM policies

#### Table 2  Block chain is different technique

| Name author | Methods | Technology | Group | Consistency | Product | Risk control |
|-------------|---------|------------|-------|-------------|---------|--------------|
| Current Proposed method | Blockchain technology | ✔ | ✔ | ✔ | ✔ | ✔ |
| Sergi et al. (2020) | Fuzzy capital budgeting using fermatean fuzzy sets | × | × | ✔ | ✔ | × |
| Keshavarz et al. (2020) | WASPAS for green construction supplier evaluation | ✔ | ✔ | ✔ | × | ✔ |
| Güll (2021) | COVID-19 testing laboratory selection problem | ✔ | × | ✔ | ✔ | × |
| Aydin (2021) | Multi-Expert Mabac Method | ✔ | ✔ | × | × | × |
| Rani et al. (2022) | A complex proportional assessment approach | ✔ | × | ✔ | ✔ | × |
| Kahraman et al. (2020) | Artificial Intelligence Technologies | × | ✔ | ✔ | ✔ | × |
| Rani et al. (2022) | complex proportional assessment | ✔ | × | ✔ | ✔ | × |
| Sindhu et al. (2022) | Approach of Decision-Making | ✔ | ✔ | × | ✔ | ✔ |
| Alkan et al. (2022) | Supply Chain Digital Transformation Strategies | × | ✔ | ✔ | × | ✔ |
| Zhou et al. (2022) | TIDIM for blockchain technology provider selection | ✔ | ✔ | × | ✔ | ✔ |

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connected to the scheming of the TrFF-TOPSIS feelings of lengthily with characteristic fuzzy numbers might donate to
TrFF decision matrix

Table 3 TrFF decision matrix

|       | GBU₁  | GBU₂  | GBU₃  | GBU₄  |
|-------|-------|-------|-------|-------|
| PS₁   | 0.11, 0.12 | 0.19, 0.11 | 0.13, 0.14 | 0.15, 0.16 |
| PS₂   | 0.11, 0.11 | 0.21, 0.23 | 0.19, 0.21 | 0.25, 0.21 |
| PS₃   | 0.19, 0.19 | 0.3001, 0.19 | 0.11, 0.13 | 0.23, 0.24 |
| PS₄   | 0.19, 0.19 | 0.93, 0.13 | 0.21, 0.23 | 0.25, 0.26 |

The collection of all fuzzy subsets of the degree of membership of the element

A fuzzy set in a set \( H \) is defined as follows:

\[ \left\{ \begin{array}{l}
\mu_f : H \rightarrow I, \quad \mu_f(h) \\
\end{array} \right. \]

where \( I = [0, 1] \) and \( 0 \leq \mu_f(h) \leq 1 \). The degree of indeterminacy is defined as \( \pi_A(x) = \sqrt{\int (\mu_A(x) - \mu_B(x))^2} \). The FFN is denoted as \( A = (\mu_A, \mu_B) \).

### 2.1 FFN and operational laws

**Definition 2.1.1** Zadeh (1965) Let \( H \) be a universe of discourse. Then the fuzzy set can be defined as: \( J = \{ h, \mu_f(h) \in H \} \). A fuzzy set in a set \( H \) is denoted by \( \mu_f : H \rightarrow I \), where \( I = [0, 1] \). The function \( \mu_f(h) \) denotes the degree of membership of the element \( h \) to the set \( H \).

The collection of all fuzzy subsets of \( H \) is denoted by \( I^H \). Define a relation on \( I^H \) as follows:

\[ (\forall \mu, \eta \in I^H ) \mu \leq \eta \iff (\forall h \in H)(\mu(h) \leq \eta(h)) \]

longthily with characteristic fuzzy numbers might donate to intensifying the skill in this concott. The main position is connected to the scheming of the TrFF-TOPSIS feelings of the joining blockchain. For this reason, selected criteria are measured by four varied authorities. In this organization, assumed standards are assessed to entree the joining outlines by seeing the blockchain feelings (Figs. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and 11).

### 2 Preliminaries

**Definition 2.1** Zadeh (1965) Let \( H \) be a universe of discourse. Then the fuzzy set can be defined as: \( J = \{ h, \mu_f(h) \in H \} \). A fuzzy set in a set \( H \) is denoted by \( \mu_f : H \rightarrow I \), where \( I = [0, 1] \). The function \( \mu_f(h) \) denotes the degree of membership of the element \( h \) to the set \( H \).

The collection of all fuzzy subsets of \( H \) is denoted by \( I^H \). Define a relation on \( I^H \) as follows:

\[ (\forall \mu, \eta \in I^H ) \mu \leq \eta \iff (\forall h \in H)(\mu(h) \leq \eta(h)) \]
**Table 5** TrEFFWA operator

|       | $GBU_1$            | $GBU_2$            | $GBU_3$            | $GBU_4$            |
|-------|--------------------|--------------------|--------------------|--------------------|
| $PS_1$| [0.04129, 0.04880, 0.06380, 0.9241, 0.9312, 0.9341] | [0.0450, 0.0525, 0.0606, 0.9261, 0.9327, 0.9354] | [0.0713, 0.0788, 0.0811, 0.9399, 0.9428, 0.9445] | [0.1254, 0.1163, 0.2381, 0.9378, 0.9531, 0.9547] |

$PS_2$ = [0.3836, 0.4282, 0.4320, 0.4440, 0.9177, 0.9181, 0.9185]

$PS_3$ = [0.0754, 0.0833, 0.0873, 0.0952, 0.9291, 0.9303, 0.9325, 0.9345]

$PS_4$ = [0.1288, 0.1296, 0.1305, 0.1314, 0.9202, 0.9207, 0.9209, 0.9212]

\[ a_1 = \left[ \frac{1}{\sqrt{1 - (1 - \lambda a_1)^2}} \right] \]

\[ a_i^2 = \left[ \frac{1}{\sqrt{1 - (1 - \lambda a_1)^2}} \right]^2 \]

**Definition 2.1.3** Let \( a = \{z, \chi\} \) be the FFNs, then the score function is \( a = z^2 - \chi^2 \).

**Definition 2.1.4** Let \( a = \{z, \chi\} \) be the FFNs, then the accuracy function is \( a = z^3 + \chi^3 \).

### 2.2 FF TOPSIS technique

**Step 1:** Describe the FF decision matrix.

**Step 2:** Describe the FEFWA operator and \( \zeta = (\zeta_1, \zeta_2, \ldots, \zeta_n) \).

\[ \text{FEFWA} (a_1, a_2, \ldots, a_n) \]

\[ = \left[ \frac{\prod_{j=1}^{n} (1 + G_j)^{\zeta_j} - \prod_{j=1}^{n} (1 - G_j)^{\zeta_j}}{\prod_{j=1}^{n} (1 + G_j)^{\zeta_j} + \prod_{j=1}^{n} (1 - G_j)^{\zeta_j}} \right]^{\frac{1}{2}} \prod_{j=1}^{n} (F_j)^{\zeta_j} \]

**Step 3:** To construct a normalized FF TOPSIS decision matrix. The normalized value \( \beta_\theta \) is calculated as follows:

\[ \beta_\theta = \left[ \frac{G_1^\theta}{\sqrt{\sum_{j=1}^{n} (G_j)^{2\theta}}} \right] \left[ \frac{F_3^\theta}{\sqrt{\sum_{j=1}^{n} (F_j)^{2\theta}}} \right] \]

**Step 4:** To construct the weighted normalized FF TOPSIS decision matrix by multiplying the normalized FF TOPSIS decision matrix by its associated weights. The weighted normalized value is given by \( w_j = B_j \).

**Step 5:** To find the +ve FF ideal solution and the -veFF ideal solution. It is shown as under:
Table 6 Normalized TrFF TOPSIS decision matrix

|       | GBU1        | GBU2        | GBU3        | GBU4        |
|-------|-------------|-------------|-------------|-------------|
| PS1   | [0.1417, 0.1671, 0.1526, 0.1518, 0.6101, 0.6100, 0.6111, 0.6121] | [0.1548, 0.1798, 0.1627, 0.1606, 0.6114, 0.6111, 0.6121, 0.6030] | [0.2453, 0.2699, 0.2199, 0.2233, 0.6205, 0.6186, 0.6187, 0.6189] | [0.4315, 0.3984, 0.5201, 0.5658, 0.6191, 0.6266, 0.6265, 0.6262] |
| PS2   | [0.6955, 0.1476, 0.1298, 0.1443, 0.6077, 0.6228, 0.6241, 0.6241] | [0.0768, 0.1731, 0.3596, 0.2152, 0.6189, 0.6190, 0.6282, 0.6193] | [0.2099, 0.3998, 0.3485, 0.3810, 0.6072, 0.6063, 0.6059, 0.1337] | [0.1329, 0.2797, 0.2551, 0.3038, 0.6096, 0.6109, 0.6109, 0.6857] |
| PS3   | [0.2643, 0.4039, 0.3944, 0.3080, 0.6231, 0.6222, 0.6213, 0.6201] | [0.2822, 0.2886, 0.3023, 0.6182, 0.6181, 0.6186, 0.6187, 0.2128] | [0.1477, 0.1573, 0.1767, 0.6041, 0.6050, 0.6056, 0.6083, 0.1343] | [0.1745, 0.1967, 0.2146, 0.6059, 0.6079, 0.6095, 0.6105, 0.7318] |
| PS4   | [0.0776, 0.1768, 0.1948, 0.2193, 0.6208, 0.6208, 0.6200, 0.6183] | [0.4121, 0.4240, 0.3963, 0.6208, 0.6208, 0.6193, 0.6193, 0.6161] | [0.2855, 0.2860, 0.3098, 0.6144, 0.6146, 0.6151, 0.6151, 0.6060] | [0.1780, 0.1714, 0.1740, 0.6090, 0.6092, 0.5996, 0.6057, 0.6057] |

\[ z^*_i = [\max_j G_j, \min_j F_j] \]

\[ z^-_i = [\min_j G_j, \max_j F_j] \]

**Step 6:** Separation of each candidate from the positive FF ideal solution that is given as under:

\[ q_i^+(B^-, B^+) = \frac{1}{2} (|G_{ij} - G_i| + |F_{ij} - F_i|) \]

**Step 7:** To compute closeness relative to the ideal solution. Relative closeness to the ideal solution is comprehended by the Equation.

\[ Z_i = \frac{q_i^+(B^-, B^+), \eta}{q_i^+(B^-, B^+), \eta} + q_i^-(B^-, B^+), \eta} \]

### 3 TrFFN and operational laws

**Definition 3.1** Let \( a_1 = \left\{ [\eta_1, \kappa_1, \xi_1, \delta_1], [A_1, Y_1, \theta_1, \Theta_1] \right\} \) and \( a_2 = \left\{ [\eta_2, \kappa_2, \xi_2, \delta_2], [A_2, Y_2, \theta_2, \Theta_2] \right\} \) be two TrFFNs and \( \lambda > 0 \), then.

\[ a_1 \oplus a_2 = \left[ \left( \frac{1}{\lambda} \alpha + \alpha \right) \right] ; \]

\[ a_1 \otimes a_2 = \left[ \left( \frac{1}{\lambda} \alpha \right) \right] ; \]

\[ (\lambda \alpha) \otimes a_2 = \left[ \left( \frac{1}{\lambda} \alpha \right) \right] ; \]

\[ \alpha \otimes (\lambda \alpha) = \left[ \left( \frac{1}{\lambda} \alpha \right) \right] ; \]

\[ (\lambda \alpha) \otimes (\lambda \alpha) = \left[ \left( \frac{1}{\lambda} \alpha \right) \right] ; \]
Table 7 Weight normalized TrFF decision matrix

|     | GBU₁   | GBU₂   | GBU₃   | GBU₄   |
|-----|--------|--------|--------|--------|
| PS₁ | 0.0032 | 0.0036 | 0.0036 | 0.0036 |
|     | 0.0037 | 0.0041 | 0.0062 | 0.0099 |
|     | 0.0035 | 0.0037 | 0.0051 | 0.0121 |
|     | 0.0036 | 0.0036 | 0.0052 | 0.0130 |
|     | 0.0140 | 0.0141 | 0.0142 | 0.0143 |
|     | 0.0141 | 0.0142 | 0.0143 | 0.0144 |
|     | 0.0142 | 0.0143 | 0.0145 | 0.0145 |
|     | 0.0143 | 0.0139 | 0.0147 | 0.0146 |
| PS₂ | 0.2172 | 0.0239 | 0.0655 | 0.0041 |
|     | 0.0461 | 0.0540 | 0.1248 | 0.0873 |
|     | 0.0405 | 0.1123 | 0.1088 | 0.0796 |
|     | 0.0450 | 0.0067 | 0.1189 | 0.0948 |
|     | 0.1897 | 0.2151 | 0.1896 | 0.1903 |
|     | 0.1945 | 0.1933 | 0.1933 | 0.1907 |
|     | 0.1949 | 0.1961 | 0.1892 | 0.1908 |
|     | 0.1050 | 0.1934 | 0.0041 | 0.2141 |
| PS₃ | 0.0028 | 0.0030 | 0.0016 | 0.0019 |
|     | 0.0044 | 0.0031 | 0.0017 | 0.0021 |
|     | 0.0042 | 0.0032 | 0.0019 | 0.0023 |
|     | 0.0004 | 0.0067 | 0.0065 | 0.0066 |
|     | 0.0067 | 0.0067 | 0.0066 | 0.0067 |
|     | 0.0067 | 0.0067 | 0.0066 | 0.0068 |
|     | 0.0067 | 0.0023 | 0.0014 | 0.0079 |
| PS₄ | 0.0007 | 0.0036 | 0.0025 | 0.0014 |
|     | 0.0016 | 0.0037 | 0.0026 | 0.0015 |
|     | 0.0017 | 0.0035 | 0.0027 | 0.0016 |
|     | 0.0019 | 0.0055 | 0.0028 | 0.0017 |
|     | 0.0019 | 0.0055 | 0.0053 | 0.0053 |
|     | 0.0053 | 0.0056 | 0.0054 | 0.0054 |
|     | 0.0054 | 0.0054 | 0.0055 | 0.0053 |
|     | 0.0054 | 0.0053 | 0.0056 | 0.0054 |

Definition 3.2 The TrFFNs are \( \mathbf{a} = \{ [\eta, \kappa, \zeta, \delta], \mathbf{A}, \mathbf{Y}, \mathbf{P}, \mathbf{G} \} \), then the score function \( \mathbf{H} \) is define as: \( \mathbf{H} = \{ [\eta, \kappa, \zeta, \delta], \mathbf{A}, \mathbf{Y}, \mathbf{P}, \mathbf{G} \} \).

Definition 3.3 The TrFFNs are \( \mathbf{a} = \{ [\eta, \kappa, \zeta, \delta], \mathbf{A}, \mathbf{Y}, \mathbf{P}, \mathbf{G} \} \), then the accuracy function \( \mathbf{H} \) is define as: \( \mathbf{H} = \{ [\eta, \kappa, \zeta, \delta], \mathbf{A}, \mathbf{Y}, \mathbf{P}, \mathbf{G} \} \).

Definition 3.4 The gathering of TrFFNs are \( \mathbf{c}_j = \{ [\eta, \kappa, \zeta, \delta], \mathbf{A}, \mathbf{Y}, \mathbf{P}, \mathbf{G} \} \) and the weight vector is \( \mathbf{\Delta} = (\Delta_1, \Delta_2, \ldots, \Delta_n)^T \) with \( \Delta_i \in [0, 1] \) and \( \sum_{j=1}^n \Delta_j = 1 \). Then TrEFFWA \( (c_1, c_2, \ldots, c_n) = \oplus_{j=1}^n \Delta_j \mathbf{c}_j \) is said TrEFFWA operator.

Theorem 3.5 The collection of TrFFNs are \( \mathbf{a}_j = \{ [\mu, S, G, H], [\mathbf{v}, \mathbf{F}, \mathbf{M}, \mathbf{N}] \} \) and the weight vector is \( \mathbf{\zeta} = (\zeta_1, \zeta_2, \ldots, \zeta_n)^T \) with \( \zeta_j \in [0, 1] \) and \( \sum_{j=1}^n \zeta_j = 1 \). Then it is said TrEFFWA operator and TrEFFWA \( \ldots \)
Fig. 1 History

Fig. 2 Model fuzzy way
4 TrFF-AHP-TOPSIS method for blockchain procedure selection

This section offers an original mixture technique joining AHP with TOPSIS by using TrFF data to discourse blockchain skill provider collection difficulties for main banks or monetary organizations. First, a hierarchical evaluative criteria scheme is constructed in the opinion of the works appraisal and single features of a blockchain, which can ration together a great presentation and apparent hazards. Following, the AHP is comprehensive to the TrFF setting to fast DMs’ doubts of the pairwise assessment finished applicable criteria, and the container is consumed to classify the consistent criterion weights of the blockchain skill suppliers. Then, the TOPSIS system is extended to the TrFF scenario to increase the general supremacy grades of the suppliers seeing the DMs’ risk dislike concerning blockchain technology, and the position consequences can rapid both impartial valuations regarding the criteria and DMs’ supple personal risk brashness finished the blockchain. Therefore, the planned TrFF-AHP-TOPSIS method can widely reflect material topographies of blockchain skill and DMs’ reasoning and emotional performance and more effectually address the blockchain skill worker collection problem. The process flow of the recommended TrFF-AHP-TOPSIS method is accessible in Fig. 3.

4.1 Depiction of the blockchain skill supplier assortment problem

Blockchain supplier selection, as a characteristic MCDM problem, is applied through a collection of decision matrices. Let $A = \{A_1, A_2, ..., A_n\}$ represent sure latent blockchain skill providers $PS = \{PS_1, PS_2, ..., PS_n\}$ denote significant evaluative criteria delivered by numerous experts $DM = \{DM_1, DM_2, ..., DM_n\}$, and the corresponding rank of specialists is denoted

---

**Fig. 3** Procedure flowchart of the offered TrFF-AHP-TOPSIS method for MCDM Difficulties

**Fig. 4** Blockchain of hierarchical evaluative
Fig. 5  Case 1

![Graph showing a bar chart for Case 1.]

Fig. 6  Case 2

![Graph showing a line graph for Case 2.]

Fig. 7  Case 3

![Graph showing a line graph for Case 3.]

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\[
\Delta = (\Delta_1, \Delta_2, \ldots, \Delta_n)^T
\]
satisfying the environments \(\sum_{j=1}^{n} \Delta_j = 1\). Moreover, the rank of the evaluative criteria is represented by \(W = (W_1, W_2, \cdots, W_n)^T\), meeting the following situations: \(\sum_{j=1}^{n} W_j = 1\). Each component in the decision matrix means the applicable candidate’s evaluative assessment on a convinced criterion from the DM.

### 4.2 TrFF-AHP-TOPSIS Technique

**Step 1:** Describe the TrFF decision matrix.

**Step 2:** Describe the TrEFFWA operator and \(\hat{\zeta} = (\hat{\xi}_1, \hat{\xi}_2, \ldots, \hat{\xi}_n)\).

\[
\text{TrEFFWA}(a_1, a_2, \ldots, a_n) = \left[\begin{array}{c}
\frac{1}{3} \left(\prod_{j=1}^{3} (1+\hat{\zeta}_j)^{\hat{\xi}_j} - \prod_{j=1}^{3} (1-\hat{\zeta}_j)^{\hat{\xi}_j}\right) \\
\frac{1}{3} \left(\prod_{j=1}^{3} (1+\hat{\zeta}_j)^{\hat{\xi}_j} - \prod_{j=1}^{3} (1-\hat{\zeta}_j)^{\hat{\xi}_j}\right) \\
\frac{1}{3} \left(\prod_{j=1}^{3} (1+\hat{\zeta}_j)^{\hat{\xi}_j} - \prod_{j=1}^{3} (1-\hat{\zeta}_j)^{\hat{\xi}_j}\right)
\end{array}\right],
\]

**Fig. 8** Case 4

**Fig. 9** Score function of IFWA operator
Step 3: To construct a normalized TrFF TOPSIS decision matrix. The normalized value $\beta_{ij}$ is calculated as:

$$
\beta = \left\{ \begin{array}{c}
\frac{1}{\sqrt{\sum_{i=1}^{n} (A_i^u)^2}} \frac{1}{\sqrt{\sum_{i=1}^{n} (A_i^l)^2}} \frac{1}{\sqrt{\sum_{i=1}^{n} (A_i^m)^2}} \frac{1}{\sqrt{\sum_{i=1}^{n} (A_i^c)^2}}
\end{array} \right\},
$$

Step 4: To construct the entropy weights.

$$
H_j = \frac{1}{\sqrt{2}} \left\{ \sin \frac{1}{2} \left( \mu_i - \mu_j \right) + \sin \frac{1}{2} \left( \mu_i - \mu_j \right) - 1 \right\}.
$$

Step 5: To construct the weighted normalized TrFF TOPSIS decision matrix by multiplying the normalized TrFF TOPSIS decision matrix by its associated weights. The weighted normalized value is given by $v_{ij} w_j = H_j$.

Step 6: To find the positive TrFF ideal solution and the negative TrFF ideal solution. It is shown as under:

$$
\bar{x}_i^+ = \left\{ \left[ \max_{j} \mu_j, \max_j S_j, \max_j G_j, \max_j H_j \right] \right\}
$$

$$
\bar{x}_i^- = \left\{ \left[ \min_{j} v_j, \min_j F_j, \min_j M_j, \min_j N_j \right] \right\}
$$

Step 7: Separation of each candidate from the positive TrFF ideal solution that is given as under:

$$
q_i^+ \left\langle \left\{ B^+, B^- \right\}, \eta \right\rangle = \left\langle \frac{1}{\frac{1}{n}} \left( \left[ \mu_i - \mu_j + |S_i - S_j| + |G_i - G_j| + |H_i - H_j| \right] \right) \right\rangle.
$$

Separation of each candidate from the negative TrFF ideal solution that is given as under:

$$
q_i^- \left\langle \left\{ B^+, B^- \right\}, \eta \right\rangle = \left\langle \frac{1}{\frac{1}{n}} \left( \left[ v_i - v_j + |F_i - F_j| + |M_i - M_j| + |N_i - N_j| \right] \right) \right\rangle.
$$

Step 8: The relative closeness to the ideal solution is comprehended by the equation.

$$
Z_i = \frac{q_i^+ \left\langle \left\{ B^+, B^- \right\}, \eta \right\rangle}{q_i^- \left\langle \left\{ B^+, B^- \right\}, \eta \right\rangle + q_i^+ \left\langle \left\{ B^+, B^- \right\}, \eta \right\rangle}.
$$
In Isolated application, a scheme is recycled to suggestion their doings though in Official application, establishments or community government, the scheme is rummage-sale to suggestion a collection of businesses (physically or manufacturing group related). TE-FOOD originates with the filled set of gears and requests wanted for the entire supply chain to tool nourishment traceability by endwise working discernibility and procedure switch.

TE-FOOD existence absorbed on nourishment track ability, delivers sole answers in agrarian industry.

It is lone the tractability answer that proposals dissimilar facilities B2B (Business-to-Business), B2C (Business-to-Consumer) and B2A (Business-to-Authorities), helping businesses, customers and establishments.

It shapes customer faith as they are talented to path the source of the nourishment creation counting all dispensation the creation experienced.

Due to good track ability and sensors, the nourishment creation that are dirty can be isolated at initial phase before it spreads to shop, plummeting numerous foodborne disease.

Controlling forms have actual viewpoint of the nourishment marketplace that assistance to recover food care regulatory nursing and implementation.

One of the curb TE-FOOD is that TFD symbolic that screenings on the Etheral net has little deal/second (15 TPS) which is comparatively slow. Likewise TE-FOOD has to expression a straight and unintended rivalry form dissimilar contestants businesses like: AMbrosus, WABI, MOD, WTC. Also TE-FOOD consuming big statistics of customers in Hungary and Vietnam, it is stressed to become contact in global marketplace.

5.1 Numerical application of TrFF TOPSIS method

The Array of HBL in Pakistan is dedicated to applying investment founded on large statistics. To understand suitable, protected, and real cross-border remittances, the Array of HBL in Pakistan means to choice the best blockchain skill supplier. A decision group connecting four DMs is shaped to select a suitable supplier from four before screened suppliers \( (PS_1, PS_2, PS_3 \text{ and } PS_4) \). The hierarchical evaluative criteria scheme to measure the presentation of the blockchain skill providers, which comprises four chief criteria \( (GBU_1: \text{technical close } GBU_2: \text{produce and amenity, } GBU_3: \text{economic issue, and } GBU_4: \text{safety jeopardy}) \). To source passable flexibility inside the assessment of the standards of the four criteria of each optional manufacturing, rulers are allowable to exploit TrFFNs.

**Step 1:** Describe the TrFF decision matrix.

**Step 2:** Describe the TrEFFWA operator and \( \zeta = (0.23, 0.24, 0.25, 0.28) \).
Step 3: To construct a normalized TrFF TOPSIS decision matrix.

Step 4: To construct the entropy weights.

\[ H_1 = 0.0231, H_2 = 0.3123, \\
H_3 = 0.0109, H_4 = 0.0088. \]

Step 5: To construct the weighted normalized TrFF TOPSIS decision matrix.

Step 6: To find positive TrFF ideal solution

\[
\begin{bmatrix}
0.0099, \\
0.091, \\
0.0121, \\
0.0130, \\
0.0140, \\
0.0141, \\
0.0142, \\
0.0139
\end{bmatrix}
\begin{bmatrix}
0.2172, \\
0.1248, \\
0.1123, \\
0.1189, \\
0.1896, \\
0.1893, \\
0.1892, \\
0.0041
\end{bmatrix}
\begin{bmatrix}
0.0028, \\
0.0044, \\
0.0042, \\
0.0067, \\
0.0065, \\
0.0066, \\
0.0066, \\
0.0014
\end{bmatrix}
\begin{bmatrix}
0.0036, \\
0.0037, \\
0.0035, \\
0.0036, \\
0.0019, \\
0.0053, \\
0.0053, \\
0.0053
\end{bmatrix}
\]

To find negative TrFF ideal solution.

\[
\begin{bmatrix}
0.0032, \\
0.0037, \\
0.0035, \\
0.0036, \\
0.0143, \\
0.0144, \\
0.0145, \\
0.0147
\end{bmatrix}
\begin{bmatrix}
0.0239, \\
0.0461, \\
0.0405, \\
0.0067, \\
0.2151, \\
0.1945, \\
0.1961, \\
0.2141
\end{bmatrix}
\begin{bmatrix}
0.0016, \\
0.0017, \\
0.0019, \\
0.0004, \\
0.0067, \\
0.0068, \\
0.0068, \\
0.0067
\end{bmatrix}
\begin{bmatrix}
0.0007, \\
0.0015, \\
0.0017, \\
0.0017, \\
0.0055, \\
0.0056, \\
0.0055, \\
0.0056
\end{bmatrix}
\]

Step 7: To separate every candidate from +ve TrFF ideal solution. It is as under:

\[ q^+_1 = 0.0655, q^+_2 = 0.1685, \\
q^-_3 = 0.0043, q^-_4 = 0.0047. \]

To separation each candidate from -ve TrFF ideal solution. It is as under:

\[ q^-_1 = 0.0053, q^-_2 = 0.4734, \\
q^-_5 = 0.0052, q^-_4 = 0.4843. \]

Step 8: The closeness of solution of the problem under consideration is given by the following equations.

### Table 8 IF decision

| \( \text{GBU}_1 \) | \( \text{GBU}_2 \) | \( \text{GBU}_3 \) | \( \text{GBU}_4 \) |
|------------------|------------------|------------------|------------------|
| \( P S_1 \)      | 0.1, 0.3        | 0.12, 0.14      | 0.9, 0.11       | 0.1, 0.3        |
| \( P S_2 \)      | 0.12, 0.13      | 0.4, 0.6        | 0.31, 0.33      | 0.112, 0.313   |
| \( P S_3 \)      | 0.34, 0.36      | 0.12, 0.13      | 0.4, 0.6        | 0.554, 0.556   |
| \( P S_4 \)      | 0.3004, 0.3006  | 0.34, 0.36      | 0.12, 0.13      | 0.4, 0.6        |

### Table 9 IFWA operator

| \( P S_1 \) | [0.2321, 0.1766] |
| \( P S_2 \) | [0.3066, 0.3812] |
| \( P S_3 \) | [0.5004, 0.2871] |
| \( P S_4 \) | [0.5246, 0.1481] |

\[ Z_1 = 0.2531, Z_2 = 0.5501, \\
Z_3 = 0.9879, Z_4 = 0.3974. \]

### 6 Comparison analysis

To favor and customary up feasibility of the optional plan, its comparison with another plan inferior upon IFSs (Atanassov and Gargov 1989) and FFWG statistics (Varma 2019) is showed with cases. Other plans are strange cases of our method plan that’s originated on TrFFN to the similar descriptive situation.

#### 6.1 IFN with existing technique

Step 1: IF decision matrix is Table 8 in given below (Table 9).

Step 2: Describe the IFWA operator and (0.1, 0.2, 0.3, 0.4).

Now applying given formula.

Step 3: The score function is

\[ \eta_1 = 0.0555, \eta_2 = -0.0746, \\
\eta_3 = 0.2133, \eta_4 = 0.3765. \]

Step 4: Given the ranking \( \eta_4 > \eta_3 > \eta_1 > \eta_2 \) and the \( \eta_4 \) is the best.

#### 6.2 FF number with existing technique

Step 1: The FF decision matrix is given in Table 10.


**Table 11** FFWA operator

|    |    |
|----|----|
| $PS_1$ | [0.0046, 0.9998] |
| $PS_2$ | [0.1277, 0.9964] |
| $PS_3$ | [0.0646, 0.9941] |
| $PS_4$ | [0.0888, 0.9696] |

**Step 2:** The FFWG operator and $(0.1, 0.2, 0.3, 0.4)$.

Applying given formula.

**Step 3:** The score function is

\[
\eta_1 = -0.9996, \eta_2 = -0.9873, \\
\eta_3 = -0.9824, \eta_4 = -0.9111.
\]

**Step 4:** Find the ranking $\eta_1 > \eta_2 > \eta_3 > \eta_4$ and $\eta_1$ is the best.

Moreover, we discuss some experiments study to reinforce our claim of developing an improved framework for TrFF-based MCDA concerns.

In (Tang et al. 2019) and (Senapati and Yager 2020), the alternatives are ranked using the relative closeness coefficient and suitability index, respectively, between the overall value of the alternatives and the ideal alternative. This is not sufficient to conclude how good or bad an alternative is. In the TrFF TOPSIS method, the benefit and the cost criteria are both considered with proposed AOs on TrFFSs which comprise a more precise outcome compared with simply dealing with benefit or cost criteria. In the

**Table 12** When there are interrelationships among any manifold criteria: The diverse approaches can grip this state

|                | 1   | 2   | 3   | 4   | 5   |
|----------------|-----|-----|-----|-----|-----|
| Colak et al.   | 0.0253 | 0.2901 | 0.3008 | 0.0621 | 0.3498 |
| (Colak et al. 2020) |     |      |      |      |      |
| Farshidi et al. | 0.0909 | 0.4056 | 0.3087 | 0.4085 | 0.0095 |
| (Farshidi et al. 2020) |     |      |      |      |      |
| Gupta (Gupta 2017) | 0.1537 | 0.1881 | -0.8601 | -0.1916 | 0.0483 |
| Holotiuk et al. (Holotiuk et al. 2019) | -0.5243 | 0.3041 | 0.3007 | 0.9721 | 0.6098 |

**Table 13** Comparison

|                  | 1   | 2   | 3   | 4   | 5   |
|------------------|-----|-----|-----|-----|-----|
| Atanassov et al. | 0.8203 | 0.6031 | 0.1625 | 0.0387 | 0.3081 |
| (Atanassov and Gargov 1989) |     |      |      |      |      |
| Hoy (Hoy 2017)   | -0.0299 | 0.3088 | 0.1995 | -0.1919 | 0.0293 |
| Ito et al.       | 0.0267 | 0.0369 | 0.3088 | 0.0801 | 0.1002 |
| (Ito et al. 2017) |     |      |      |      |      |

**Table 14** Different existing techniques

|                  | Score Function | Ranking | Final Ranking |
|------------------|----------------|---------|---------------|
| MCDM (Colak et al. 2020) | $\eta_1 = 0.2014$, $\eta_2 = 0.8755$, $\eta_3 = 0.5811$, $\eta_4 = 0.6711$ | $\eta_2 > \eta_3 > \eta_1$ | $\eta_4 > \eta_3 > \eta_2$ |
| Z-hesitant (Karaşan et al. 2021) | $\eta_1 = 0.2014$, $\eta_2 = 0.8755$, $\eta_3 = 0.5811$, $\eta_4 = 0.6711$ | $\eta_2 > \eta_3 > \eta_4 > \eta_1$ | $\eta_2 > \eta_3 > \eta_4 > \eta_1$ |
| Pythagorean operators (Jin et al. 2019) | $\eta_1 = 0.0213$, $\eta_2 = 0.1745$, $\eta_3 = 0.0545$, $\eta_4 = 0.0893$ | $\eta_2 > \eta_3 > \eta_1 > \eta_4$ | $\eta_2 > \eta_3 > \eta_1 > \eta_4$ |
| Vikor method (Zhou and Chen 2021) | $\eta_1 = 0.0213$, $\eta_2 = 0.1745$, $\eta_3 = 0.0545$, $\eta_4 = 0.0893$ | $\eta_1 > \eta_2 > \eta_3 > \eta_4$ | $\eta_1 > \eta_2 > \eta_3 > \eta_4$ |
meantime, it increases the practicality of assessment data and the precision of outcomes as well.

The main benefit of the introduced TrFF model is capable of assessing any MCDA issues with uncertainty through TrFFNs as well as IFs and FFNs (Atanassov and Gargov 1989; Senapati and Yager 2019a) as described in the previous sections.

The proposed TrFF framework, which is utility or scoring degree-based model for MCDA, selects an option with the highest utility degree; therefore, the concern is how to assess the prior multi-criteria utility degree for an appropriate decision setting, whereas the extant models, which are compromise degree models, select an option which is nearest to the ideal solution.
The proposed TrFF technique is one of the robust and novel MCDA utility measuring methods. This framework is a combination of TrFFWA operator. The ranking of TrFF-TOPSIS technique is strengthening than PIS and NIS. The proposed method enables to reach the highest accuracy of assessment for utilizing the proposed approach for optimization of weighted AOs.

All the existing AOs utilize different operations on FFNs and IFS information, it is necessary to propose some neutral AOs about them due to that we are neutral in several issues and need to be treated fairly. Here, we have implemented TrEFFWA aggregation operators to get more reasonable outcomes.

7 Conclusion

The analysis part for valuation of data in a numerous existing extension of FSs is limited, making it hard to manage with the problem of evaluating blockchain technology under a complex condition, which is full of hesitations. To overcome this difficulty, we have employed a new generalization of FSs, called as TrFFNs. We define TrFF data based on decision-making. Define the Einstein aggregation operator and operational laws. We apply the Einstein operator on TrFF-TOPSIS technique, based on the TrFFEFWA operator, a general framework has been developed for MAGDM with TrFF-TOPSIS data. The suggested TrFF-TOPSIS decision framework combines TrFF with TOPSIS in the assessment process, to determine the subjective weights of attributes and to evaluate blockchain strategies. To determine the normalized solution of every value, TrFF-TOPSIS uses PIS and NIS as the reference points for distance calculation, which will provide more potential information’s, realistic case study on the assessment of blockchain technology and demonstrate the practicability and validity of the suggested technique.

It is perceived that the method proposed in this work stretches a massive variety for articulating assessment data, which facilitates DEs in evaluating blockchain technology efficiently and flexibly. The experimental findings suggest that using our technique to establish the finalized blockchain technology selection scheme depending on the ranking outcomes is acceptable and adequate. Furthermore, the outcomes of an analysis of different approaches demonstrate that this approach has substantial benefits in terms of exploring multi-layer diverse relationships between attributes and reducing the influence of immense importance of assessment information (Tables 11, 12, 13, 14 and 15).

This research also link-up a collection of data with a relationship, which indicated that the selection of simulated data is addressed in our suggested research. In future studies, we plan to extend the proposed structure further by introducing new characteristics, including the use of TrFF probabilistic aggregations. Additionally, we will discuss additional decision-making aspects like cluster analysis, performance analysis, sustainable city logistics, risk investment assessment, Wireless Sensor Networks, capital budgeting techniques, home buying process, and other domains under the uncertain environment.

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