Multicriteria Decision Making on 3D printers for economic manufacturing using Neutrosophic environment

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Abstract

Multicriteria group decision-making scenarios with a large number of criteria values may be challenging for experts to control. This is a result of the specialists' need to consider an excessive amount of data. They find it difficult to make the optimal decision since the possibilities overwhelm them. We propose a novel multicriteria group decision-making method that methodically eliminates the initial set of criterion values in order to address this issue. One of the most promising emerging technologies currently in development is an additive manufacturing (AM), which includes 3D printing. It has been hypothesized that 3D printing technology could eventually replace the conventional production machinery that is commonly used in the industrial sector. Making conclusions through accurate figures is difficult for decision-makers due to the complexity and ambiguity of reality. Neutrosophic ensembles are used to tackle uncertainty and indeterminacy in a practical environment. By concentrating on ranking the smaller set of criterion values, the proposed method enables the experts to carry out the group decision-making process. As a result, a relaxed decision-making environment is created, allowing the experts to handle a reasonable amount of information while still making decisions. To demonstrate the decision process of a 3D printer, we combine a single valued Neutrosophic with hybrid score and accuracy function, the single valued Neutrosophic number ranking approach, and the single valued Neutrosophic score and accuracy function. To determine the best attributes, the score function was used to rank the total values of each possibility. Concrete examples have been given to support the suggested solution to the multi-attribute decision-making problem (MADM).

Keywords: 3D printer, Neutrosophic Logic; Multicriteria decision making, knowledge based system, Decision support system.

1.Introduction:

Numerous fields are affected by Decision Making (DM) difficulties. Assessment of the proof in DM cases often depends on many factors rather than one. It's also becoming more difficult for decision-makers to evaluate all relevant aspects of a problem as the intricacy of the technical environment rises. Therefore, complex decision problems are often tackled by experts who pool their knowledge and experience. There are a variety of approaches that have been developed to handle these complex Multi Criteria Decision making (MCDM) problems. [17] The field of additive manufacturing (AM), which includes 3D printing, is often regarded as the most promising of the developing technologies currently under development. It has been suggested that 3D printing technology could eventually take the place of conventional production equipment widely used in the industrial industry. There are seven main categories of 3D printing technology. Regarding 3D printing, each method is entirely distinct from the others (i.e., operation, material usage, and no wastage) [44]. A product's final cost includes every cost incurred during production. The most crucial step is to think about the machine's characteristics and cost before production begins. Furthermore, the price of the American-made object will be determined by the total production expenses. The pricing of the product could then be reduced by selecting an AMM with desirable characteristics at an affordable price [7]. Therefore, the purpose of this study is to use one of the multi-criteria decision-making (MCDM) tools—the analytical hierarchy process—to address a decision-making issue raised by the AMM selection (AHP). The MSME begins selecting an FDM machine for its structural and doll product by requesting price quotes from several AM manufacturers. Extruder type, and machine weight should all be taken into account while selecting the optimum machinery for the project. AHP relies on criteria developed in collaboration with those making the calls. AHP requires decision-makers to answer the common Saaty's scale criterion questions to produce the pair-wise matrix [67].

AM has the ability to produce materials with the most intricate geometric features while using little bulk and waste. AM is a compelling material-saving solution with its low material costs and independent characteristics that allow for control of process parameter customization. In recent years, 3D printing, also known as additive manufacturing, has garnered interest from every primary industry. The conventional industrial production system is in crisis, and AM is the root of the problem (CM) [23]. "Compared to traditional manufacturing methods, additive manufacturing is superior at creating geometrically rigid material structures [81]. As an added benefit as seen in CM, AM excels at bypassing the need for an integrated assembly in favor of a more straightforward, layer-by-layer approach to material preparation. The high prototype production cost, the increased production rates, the high prices of the product itself, and the difficulty of performing real-time operational tests are all reasons that make AM challenging to implement" stated by [47]. Although AM prototypes are more expensive than CM ones, they provide significant benefits in terms of reduced production time [33].

Over the past few decades, the Neutrosophic has evolved alongside its ecosystem. Multiple subjects benefit from using a Neutrosophic environment, including logic, statistics, algebra, neural networks, etc. Given the inherent uncertainty in most real-world decision-making scenarios, philosophers' sets provide a promising solution. Uncertainty is inherent in situations that occur in the real world, and environmental factors often contribute significantly to it. [49]. The outcomes of neutron star environments are applied to a new facet of traffic management. When it comes to managing traffic, neutrality plays a crucial role. The data is indeterminate, and the issues of membership and non-membership are addressed.

The potential for sustainability is enhanced by the fact that 3D printing is a novel manufacturing method with far-reaching environmental impacts across the entire product life cycle. Additive manufacturing constructs items layer by layer rather than chopping away from a greater volume, drastically lowering resource requirements and production waste. Traditional manufacturing generates waste because raw materials must undergo subtractive procedures to be transformed into finished goods [46]. Due to the additive nature of 3D printing, no waste is generated. With most 3D printing technologies, the only waste is the support structures created with the product and then taken out after manufacturing.

Further, 3D printing helps cut down on defective product waste [34]. Due to this improvement in resource efficiency, less energy is needed to produce or transport materials. According to [21], 3D printing might drastically cut down on or even eliminate production waste, but the technique has to be validated before it can be widely utilized.

3D printing reduces manufacturing energy requirements by eliminating intermediaries and speeding up production. These energy-efficient production methods also reduce carbon dioxide emissions. The carbon footprint of shipping may also be reduced thanks to 3D printing [55]. The carbon footprint associated with production and transportation of these goods can be reduced. Suppose 3D printing technologies are adopted on a large scale. In that case, production speeds are increased, and additional printable materials are made accessible, [35] argues the industry's net CO2 emissions and energy usage might be reduced. Additionally, they warn that the sustainability gains from 3D printing might be nullified by a "rebound effect" if the production volume is raised because of the technology's enhanced efficiency.

A pool of molten metal receives metal powder, which is then deposited as new metal by laser melting. This process is repeated until the pool of molten metal tank is full. Fused deposition modeling [27] involves heating a filament of thermoplastic polymer and then extruding it onto a surface. Despite the fact that the materials employed in this method are more easily recyclable, this method is still preferred.

These pillars have not received the attention they deserve since it was believed that they were superfluous [24]. Although this is a difficulty, there is a solution described in [20] that involves crushing the supports and then extruding them into a filament using the new material. This is a technique that may be used to solve the problem. The acrylonitrile butadiene styrene (ABS) plastic, on the other hand, deteriorates under the effect of heat generated by the FDM printer. Research is being carried out on new polymers with the hope of improving their potential for recycling [22]. which is also an area for development [16]. The material choice might influence the sustainability of 3D printing.

Laser metal deposition and other processes involving the melting metal powders offer the environmental benefits when reusing the material but are also very energy intensive. Although FDM techniques offer a reduced energy footprint, they have the additional drawback of increased emissions [59]. "Toluene, ethylbenzene, and formaldehyde are all recognized carcinogens", and [45] discovered that "FDM with ABS plastic generated substantial amounts of these chemicals. Although [26] demonstrated that "VOCs are released during 3D printing procedures using PLA, these emissions were minimized when PLA was used instead of ABS, yielding substantially less particulate matter and no VOCs". In both the best and worst-case scenarios for printing, the amount of volatile organic compounds is far below occupational exposure levels, posing no threat to human health.

EcoPrinting, suggested by [69], is a 3D printing procedure that uses waste polymers as a source material and has a negligible environmental impact. An integrated solar battery charging system and other low-power components help the EcoPrinting system significantly reduce energy consumption [15]. To help the people of the Solomon Islands, this technique has been used to print pipe couplers and plumbing seals as part of a humanitarian assistance project [14]. ABS plastics were employed in the EcoPrinting process applied to plastic from vehicle parts and technological debris collected from a Solomon Islands landfill and local companies [43]. The Tolerances for filaments produced from recycled material are equivalent to those of filaments sold commercially [1]. By functioning without an electricity connection and utilizing collected ABS plastic waste as the printing feedstock, the EcoPrinting system has successfully demonstrated the potential improvements in 3D printing.

Unlike the CM mode, AM mode allows for a more targeted counter design. [2] studied the topic of choosing individualized procedures in healthcare. This work enhanced a strategy for selecting functions in AM's fabrication of novel materials and replacement components [3]. A practical method for reducing the likelihood of AMM failure is to systematically evaluate which AMM is the most effective. It'll boost AMM's productivity. Art critics [13] examined additive manufacturing, which decreases waste by utilizing fewer powder particles to create end products, and how the absence of process selection tools is a wasted economic opportunity.

AM stocks are beginning to register as part of the third wave of manufacturing by creating industry-spanning prototype jewels. [6] demonstrated the AM sectors manufacturing benefits in terms of lead time and time to market by comparing several fast prototype methods. Unlike traditional manufacturing methods, AM does not require the use of tools throughout the creation process, as noted by [37]. The result of this is mass manufacturing. How to choose the RP processes is in detail by [63], who use a modified matrix technique and graph theory to explain their findings. [78] detailed a comparison of genetic models for determining the optimal procedure in fast prototyping in terms of build cost, build duration, and surface roughness. According to the findings of [12], the rule-based expectation system will address the issues with AM's process selection that have been posed in the business and academic communities. Research on RP methods follows a topic-specific methodology that takes into consideration criteria such as strength of building materials, accuracy, prototypes, cost, elongation, and build time [11]. A product's roughness, precision, speed, price, and mechanical qualities were quantitatively investigated [10]. Furthermore, studies have investigated how AMMs use marginally fewer raw resources. [80] found that, when it comes to orthodontists' applications and multimodal 3D face recognition, 3D printing offers the most outstanding accuracy and lowest material waste.Studies by [79] and [77] have shown that the structure of AMMs affects their mechanical characteristics and is crucial for maintaining these qualities stable. Newer multiple-choice problems with numerous criteria and solutions may be solved with the help of the MCDM method. Using prior studies' literature, the following are the advantages and applications of MCDM.

3D printing as part of a more significant educational effort to produce pre-scanned bones for use in teaching anatomy" [3] and [4].

Researchers at "Australia's Monash University" have invented a revolutionary technique for 3D printing cadaveric orbital separation incisions in ophthalmology and optometry teaching and training [25]. 3D printing is expected to significantly improve students' educational experience in STEM fields. In reviewing the efforts of the "European Federation of Chemical Engineers" Working Party on Education's efforts over the previous decade, Gillet[56] 200 highlights three crucial aspects of chemical engineering education: curriculum creation, individual growth, and ongoing education. Middle and high school teachers were the target audience for [64] a three-day 3D printing workshop, which included online educational and visual resources. They demonstrated the potential of open-source 3D printing technology to enhance learning by encouraging active students' participation in all subjects. Loy [60] showed how 3D printing can combine eLearning and making to revolutionize how product design is taught in the classroom. In their research, [76] shows how a conceive-design-implement-operate framework may balance pedagogical theory, technology training, and classroom instruction. However, in 2013, an MIT research team led by [18] launched 4D printing, which has aided in developing intelligent materials. Fourth-dimensional printing (4D printing) is a development of 3D printing in which time is included as a fourth dimension. Depending on the stimuli (such as heat, ultraviolet light, or water), the printed form may change over time, making it a dynamic structure with malleable features and functions [74],[75]. Although this development has expanded the application of digital manufacturing's application, it still needs expertise in several fields (such as mathematics, mechatronics, mechanical engineering, and chemical engineering). New intelligent engineering materials have been exhibited and studied recently, including temperature- and pH-controlling smart valves, adaptive pipes, sensors, and soft robotics [50].

I3Mote is only one example of open-source software that has been made available to facilitate the creation of products based on integrated hardware and software. Industry 4.0, derived from the notion of a "smart factory," is an umbrella term for the IoT built on cyber-physical systems (CPS) that integrate virtual and real-world settings [43],[42],[41].

"Advanced robotics, additive manufacturing, augmented reality, simulation, horizontal and vertical integration, the industrial internet, the cloud, cybersecurity, and big data and analytics" are the nine pillars upon which Industry 4.0 rests [48]. Germany's "Industry 4.0" program, launched in 2011, aims to digitalize the manufacturing process [51]. This program is responsible for coining the phrase "Industry 4.0" and developing the architectural reference model that underlies the concept.

Regarding consolidation and integration of the high-tech industries and guaranteeing the country's technical leadership, Industry 4.0 in Germany is based on the High Tech 2020 Strategy. Singapore's "Smart Nation Program," Japan's "Industrial Value Chain Initiative," China's "Made in China 2025," and the United States' own "Smart Manufacturing" all outline similarly ambitious goals [73] and [72]. Most of Malaysia's industrial industries are either highly mechanized or involved in mass production. To raise awareness of and contribute to the development of a comprehensive national strategy for Industry 4.0, the government has held discussions with a wide range of stakeholders and implemented several public outreach initiatives [5].

Optimizing part geometries, for instance, is crucial in the design phase because it can affect the environmental impact [52]. In some other cases, though, the decision-maker doesn't consider them.

seeing widespread usage in fast prototyping [53] and [54]. Others share some features of one 3D printing technology because they share similar underlying principles. In contrast, other features are distinct because they reflect the technology's regulations and lead to distinctive differences in the characteristics of the printed parts.

Among these procedures. AM technique that uses a liquid bonding agent dropped over powder particles to hold them together. By repositioning the print head and carefully depositing the bonding agent, a BJ printed component is created [57]. When printing with expensive materials, the ability to print without anchoring the powder on a build plate is a significant time and cost saver. Manufacturing ceramic components is a typical use case for BJ. Recent research [58] demonstrates that BJ-printed components have enhanced bulk density, making them ideal for metallic foam frameworks and approaching completely dense stainless-steel parts. One of the benefits of BJ's is the high resolution that makes it possible to apply finishes with a lot of detail.

Direct Energy Deposition (DED) "processes use focused energy to melt materials directly as they are added to the workpiece in a layer-by-layer fashion. A laser, electron beam, or arc lights are often used as the focused energy source, while the raw materials take the shape of a wire or powder [61],[62] and [65]. DED printing requires a greater quantity of materials than other methods. DED-printed components can better resist fatigue" [66]. New studies reveal that the particle capture efficiency of DED varies with the working distance and may improve with an increasing material in the surface temperature [68].

Melt extrusion (ME) is like the conventional plastic extrusion method; both involve the melting of the material being shaped. A typical ME method is fused deposition modeling (FDM), where a nozzle deposits the material in a soft and semi-liquid condition onto a building platform, a little bit at a time, to create an 3D object. However, ME can create more intricate components than the extrusion method while having a slower manufacturing rate. ME often has the lowest price tag among AM technologies, which helps explain why it is the most widely used 3D printing option. The print speed, process parameters, and thermal activities of the FDM method have all been improved, and much work has been put into developing new materials [70],[71] and [40].

Additive manufacturing (AM) techniques that use a bed of powdered input material that falls under the umbrella term of powder bed fusion (PBF) [38]. By spreading a small layer of powdery material and then fusing it at particular points, the 3D object is printed. Possible sources of energy include a laser, electron beam, or infrared light. Post-processing steps, such as blowing away debris or lifting the printed product off the platform, are commonplace in print-on-demand fabrication (PBF). Their distinct microstructures cause bulk anisotropy of the PBF components; however, recent research suggests that it may be reduced by using a broad beam.

A vat is used to perform the VP technique, during which the liquid-photosensitive resin is polymerized. When the resin is exposed to a laser or an arc light source, a solid three-dimensional component could be produced as a result of a chemical reaction. There are many different kinds of VP, but some examples are stereolithography, the digital light process, and the continuous liquid interface product [39] and [36]. Stereolithography is one example. New research suggests that the "bottom-up" and "top-down" print methods may provide different results [8] and [9] for components that have certain geometries, including those with parts with a length/diameter ratio that is greater than 2. One of the first steps in developing a useful cost model is determining the extent to which the model will be used. Several broad AM processes that include supplementary AM process phases have been reported in the literature. At this point in the process, the raw ingredients are additionally assembled [19]. Powdered materials may require sieving or mixing, and "material formulation" may be required for liquid materials in order to get depositable materials. Raw materials may also need to be placed into cartridges or containers and stored in a method that prevents them from degrading for a sufficient amount of time, but this will depend on the specifics of the process and the machine's design [28],[29] and [30].

Setting up the AM machine and its control system is a prerequisite before the construction begins. There are the AM systems, the energy exposure devices, the climate control system, and the control computers to configure. Once this process is complete, the appropriate control proper control parameters may be adjusted [31]. The method for matter deposition or energy delivery varies between AM techniques [32].

A relationship function called FuzzySet(FS) was used to tackle the majority of the uncertainty problems that exist in the actual world, and it was thoroughly explained.[11] uses to expand upon the intuitionistic fuzzy set (IFS) notion discussed above. Instead, a number of approaches to tackling the uncertainty problem have been developed, such as generalised orthopairfuzzy sets [18] N-valued interval Neutrosophic [31] generalised interval-valued triangular IFS, JY. Neutrosophic multicriteria is a method of decision-making that integrates various criteria or elements, occasionally with scant or unclear data, to reach a result [82]. With the use of a mathematical model created using a double bounded rough Neutrosophic set, the expression of the students is evaluated using real-time data gathered by photographing them in relation to various subjects [83]. The suggested study mentions the principal medical areas that NIP can provide for image segmentation from DICOM pictures. It has been found to be a superior method due to the way it handles ambiguous information [84]. Understanding stress and creating strategies to lessen its effects on voice recognition and human-computer interaction systems are the goals of this research [85]. In this article, we present a method for calculating a system's expected costs under various conditions. The uncertainty in the various model parameters are managed using the trapezoidal bipolar Neutrosophic numbers [86]. In this paper, complex group decision-making scenarios are addressed using the dynamic programming method, where the preference data is represented by linguistic variables [87]. The method's advantage is that it can be used without a lower membership function for falsehood, which results in a sizable reduction in calculation time [88]. In an effort to address the traffic problem, this study made an effort to provide a general overview of each approach. Numerous academics that are now studying traffic flow, traffic accident diagnostics, and its hybridization are expected to benefit from the proposed study [89]. This work reveals that neurosophic multiple regression is the most useful model for uncertainty, as opposed to conventional regression models [90], [91], and [92]. To achieve the lowest inspection cost possible, we will compose the issue language appropriately for such a case in this study before building the appropriate mathematical model [93]. This framework takes into account the components of Industry 5.0. The most important related elements and strategies can be found by first reviewing the relevant experts and body of published research [94]. Reducing HCWT through appropriate treatment is vital for the region's economic and environmental wellbeing. In order to address single-valued neutrosophic group decision-making issues with a shortage of weight data, this research develops a novel multi-criteria decision-making technique [95].

2.Neutrosophic sets

Assume that X = x1, x2,..., xm (m ≥2) is the set of decision-makers or experts, y= y1, y2,..., yq (q≥ 2) is the collection of criteria, and A=A1,..., An (n ≥ 2) is the set of logistics centres.

The weights of the decision-makers are completely unknown in the group decision-making problem, but the weights of the criteria are only partially understood. These weights have never been assigned before.We create a method based on the hybrid score-accuracy function using linguistic variables to address the MCDM problem with uncertain weights in a single-valued Neutrosophic environment. The suggested method's steps for resolving MCGDM are listed below.

Definition 2.1(F. Smarandache 2005)

Let X be the universal set, then Neutrosophic set is defined as $S = \{(T_S(x), I_S(x), F_S(x)), x \in X\}$ where $T_S(x), I_S(x), F_S(x) \in [0,1]$ and $0 \le T_S(x) + I_S(x) + F_S(x) \le 3$.

Definition 2.2(H. Wang 2010)

Let X be the universal set, then SVNS is defined as $\dot{S} = \{(T_{\dot{S}}(x), I_{\dot{S}}(x), F_{\dot{S}}(x)), x \in X\}$ where $T_{\dot{S}}(x), I_{\dot{S}}(x), F_{\dot{S}}(x) \in [0,1]$ and $0 \le T_{\dot{S}}(x) + I_{\dot{S}}(x) + F_{\dot{S}}(x) \le 3$.

Definition 2.3 (H. Wang 2005)

Let X be the universal set, then IVNS is defined as $\dot{S} = \left\{\left(\left(T_{\dot{S}}^U(x), T_{\dot{S}}^L(x)\right), \left(I_{\dot{S}}^U(x), I_{\dot{S}}^L(x)\right), \left(F_{\dot{S}}^U(x), F_{\dot{S}}^L(x)\right)\right), x \in X\right\}$

where $T_{\dot{S}}(x) = \left(T_{\dot{S}}^U(x), T_{\dot{S}}^L(x)\right) \in [0,1], \left(I_{\dot{S}}^U(x), I_{\dot{S}}^L(x)\right) \in [0,1], (F_{\dot{S}}^U(x), F_{\dot{S}}^L(x)) \in [0,1]$ and $0 \le T_{\dot{S}}^U(x) + I_{\dot{S}}^U(x) + F_{\dot{S}}^U(x) \le 3$.

Algorithm

1.Creating the choice matrix.

2.Evaluate the hybrid score accuracy matrix.

3.Calculate the average matrix in step three.

4.Calculating the weights.

5.Calculate the average accuracy matrix.

6.find the weight model for criterion

7.compare the options

8.Finish in end step

3. Score accuracy functions using the Multi criteria decision making(MCDM) technique in a single-valued Neutrosophic environment

Based on the five factors, including precision (C1), speed (C2), price (C3), surface roughness (C4), and friendly use (C5). The weights of the decision-makers are completely unknown in the group decision-making problem, but the weights of the criteria are only partially understood. These weights have never been assigned before. We create a method based on the hybrid score-accuracy function using linguistic variables to address the MCDM problem with uncertain weights in a single-valued Neutrosophic environment. The following is a list of the stages for resolving MCGDM using the suggested method. Assume that the best 3D printing requires an optimization 3D printer. Three 3D printers are available: P1, P2, and P3. To choose the most relevant criterion based on five criteria (C1,C2,C3,C4 and C5), Four decision-makers or specialists (D1, D2, and D3) have been assembled into a committee.

Thus, linguistic factors are used by the three decision-makers. Conversion of linguistic variables and Single value is shown in Table 1.in table 2,3 and 4 is linguistic phrase presented.

Table 1 linguistic scale and corresponding single value Neutrosophic

Linguistic variable	Single value Neutrosophic
Very poor (VP)	(.01 .98 .98)
Poor (P)	(.15 .75 .85)
Good(G)	(.65 .45 . 35)
Very good (VG)	(.95 .05 .05)

Table 2 linguistic phrase for D1

	C1	*C2*	*C3*	*C4*	*C5*
P1	G	G	P	G	VG
P2	VG	VP	G	G	P
P3	G	P	G	P	G

Table 3 linguistic phrase for D2

	C1	C2	C3	C4	C5
P1	VG	G	G	G	P
P2	G	VG	P	G	G
P3	G	VG	VP	G	P

Table 4 linguistic phrase for D3

	C1	C2	C3	C4	C5
P1	G	G	VG	P	G
P2	VG	G	G	G	P
P3	G	VG	G	P	G

Decision matrix for corresponding linguistic phrase

$$Dm1 = \begin{bmatrix} (.65.45.35) & (.65.45.35) & (.15.75.85) & (.65.45.35) & (.95.05.05) \\ (.95.05.05) & (.01.98.98) & (.65.45.35) & (.65.45.35) & (.15.75.85) \\ (.65.45.35) & (.15.85.85) & (.65.45.35) & (.15.75.85) & (.65.45.35) \end{bmatrix}$$

$$Dm2 = \begin{bmatrix} (.95.05.05) & (.65.45.35) & (.65.45.35) & (.65.45.35) & (.15.75.85) \\ (.65.45.35) & (.95.05.05) & (.15.75.85) & (.65.45.35) & (.65.45.35) \\ (.65.45.35) & (.95.05.05) & (.01.98.98) & (.65.45.35) & (.15.75.85) \end{bmatrix}$$

$$Dm3 = \begin{bmatrix} (.65.45.35) & (.65.45.35) & (.95.05.05) & (.15.75.85) & (.65.35.45) \\ (.95.05.05) & (.65.45.35) & (.65.45.35) & (.65.45.35) & (.65.45.35) \\ (.65.45.45) & (.95.05.05) & (.65.45.35) & (.15.75.85) & (.15.75.85) \end{bmatrix}$$

Now, we choose the best 3D printing option using the mentioned method. We choose = 0.5 to illustrate the computation process.

Equation can be used to extract the hybrid score-accuracy matrix from the decision matrix.

The existing method Surapati Pramanik(2016)

$$A_{ij}^{s} = \frac{1}{2}\alpha\left(1 + T_{ij}^{s} - F_{ij}^{s}\right) + \frac{1}{3}(1-\alpha)\left(2 + T_{ij}^{s} - I_{ij}^{s} - F_{ij}^{s}\right) \quad (1)$$

Proposed model

$$A_{ij}^{s} = \frac{1}{6}\alpha\left(T_{ij}^{s} + 2I_{ij}^{s} - 1\right) + \frac{1}{3}\left(2 + T_{ij}^{s} - I_{ij}^{s}\right) \quad (2)$$

Using the above equation to find the hybrid score matrix for existing and proposed methods hybrid score matrix existing methods

$$Hybrid\ Score\ matrix\ 1 = \begin{bmatrix} .633 & .633 & .167 & .633 & .95 \\ .95 & .016 & .633 & .633 & .167 \\ .633 & .167 & .633 & .167 & .633 \end{bmatrix}$$

$$Hybrid\ Score\ matrix\ 2 = \begin{bmatrix} .95 & .633 & .633 & .633 & .167 \\ .633 & .95 & .167 & .633 & .633 \\ .633 & .95 & .016 & .633 & .167 \end{bmatrix}$$

$$Hybrid\ Score\ matrix\ 3 = \begin{bmatrix} .633 & .633 & .95 & .883 & .742 \\ .95 & .633 & .633 & .633 & .167 \\ .633 & .95 & .633 & .167 & .633 \end{bmatrix}$$

hybrid score matrix proposed methods

$$Hybrid\ Score\ matrix\ 1 = \begin{bmatrix} .813 & .633 & .688 & .813 & .779 \\ .971 & .609 & .279 & .424 & .938 \\ .813 & .779 & .504 & .488 & .821 \end{bmatrix}$$

$$Hybrid\ Score\ matrix\ 2 = \begin{bmatrix} .971 & .396 & .563 & .813 & .613 \\ .813 & .513 & .871 & .971 & .563 \\ .813 & .513 & .871 & .971 & .609 \end{bmatrix}$$

$$Hybrid\ Score\ matrix\ 3 = \begin{bmatrix} .813 & .613 & .688 & .813 & .513 \\ .971 & .396 & .563 & .813 & .613 \\ .813 & .513 & .513 & .971 & .396 \end{bmatrix}$$

Average matrix

$$H_{ij}^{\#} = \frac{1}{n}\sum_{x=1}^{m} H_{ij}^{x}$$

The average matrix existing methods

$$H_{ij}^{\#} = \begin{bmatrix} .738 & .633 & .583 & .717 & .635 \\ .844 & .533 & .477 & .633 & .322 \\ .633 & .688 & .428 & .322 & .478 \end{bmatrix}$$

The average matrix proposed methods

$$H_{ij}^{\#} = \begin{bmatrix} .865 & .540 & .646 & .813 & .635 \\ .918 & .506 & .571 & .736 & .704 \\ .813 & .601 & .748 & .809 & .609 \end{bmatrix}$$

3.1 CORRELATION COEFFICIENT BETWEEN $H_{ij}^{\#}$ AND H_{ij}^{x}

$$c_x = \sum_{i=1}^{m} \frac{\sum_{j=i}^{n} H_{ij}^{x} H_{ij}^{*}}{\sqrt{\sum_{j=1}^{n}\left(H_{ij}^{x}\right)^2}} \frac{1}{\sqrt{\sum_{j=1}^{n}\left(H_{ij}^{*}\right)^2}} \quad (3)$$

correlation coefficient of existing methods

$$H1^*H_{ij}^{\#} = \begin{bmatrix} .468 & .401 & .097 & .454 & .588 \\ .802 & .008 & .302 & .401 & .053 \\ .401 & .011 & .271 & .053 & .302 \end{bmatrix}$$

$$H2^*H_{ij}^{\#} = \begin{bmatrix} .702 & .401 & .369 & .454 & .103 \\ .534 & .506 & .079 & .401 & .204 \\ .401 & .654 & .006 & .204 & .079 \end{bmatrix}$$

$$H3^*H_{ij}^{\#} = \begin{bmatrix} .467 & .401 & .554 & .633 & .459 \\ .802 & .337 & .302 & .401 & .053 \\ .401 & .654 & .271 & .053 & .302 \end{bmatrix}$$

correlation coefficient of proposed methods

$$H1^*H_{ij}^{\#} = \begin{bmatrix} .703 & .330 & .444 & .660 & .494 \\ .891 & .308 & .159 & .312 & .661 \\ .660 & .469 & .377 & .394 & .499 \end{bmatrix}$$

$$H2^*H_{ij}^{\#} = \begin{bmatrix} .840 & .214 & .363 & .660 & .389 \\ .745 & .259 & .497 & .714 & .396 \\ .660 & .308 & .652 & .786 & .370 \end{bmatrix}$$

$$H3^*H_{ij}^{\#} = \begin{bmatrix} .703 & .331 & .444 & .660 & .325 \\ .891 & .200 & .321 & .597 & .431 \\ .660 & .308 & .652 & .786 & .240 \end{bmatrix}$$

Table 5 proposed and existing values

	Proposed values	Existing value
$\sum_{j=i}^{\rho} h_{ij}^{1} h_{ij}^{*}$	2.632679398	2.184668
$\sqrt{\sum_{j=1}^{\rho} \left(h_{ij}^{1}\right)^2}$	2.612882	2.134
$\sqrt{\sum_{j=1}^{\rho} \left(h_{ij}^{*}\right)^2}$	2.46342	1.478062

$\sum_{j=i}^{\rho} h_{ij}^{2} h_{ij}^{*}$	2.331893056	1.730445
$\sqrt{\sum_{j=1}^{\rho} \left(h_{ij}^{2}\right)^{2}}$	2.466105	1.733
$\sqrt{\sum_{j=1}^{\rho} \left(h_{ij}^{*}\right)^{2}}$	2.441935	1.315464
$\sum_{j=i}^{\rho} h_{ij}^{3} h_{ij}^{*}$	1.390534	2.777134
$\sqrt{\sum_{j=1}^{\rho} \left(h_{ij}^{3}\right)^{2}}$	2.777134	1.259
$\sqrt{\sum_{j=1}^{\rho} \left(h_{ij}^{*}\right)^{2}}$	2.647297	1.179209

$$C_1 = \frac{2.184668}{12.134\ x1.478062} + \frac{1.730445}{1.1.733\ X\ 1.315464} + \frac{31.390534}{1.259\ X\ 1.179209} = 3.7385$$

C2=3.8986,*C3*=4.260

Table 6 proposed and existing C value

	proposed	Existing
C1	2.942516	3.7385
C2	2.908786	3.8986
C3	2.980633	4.260

Table 6 present the C value of the both methods

3.2 Decision maker's weights determination

$$\vartheta_x = \frac{C_1}{\sum_{x=1}^{n} C_x}, 0 \leq \vartheta_x \leq 1 \; for \; x = 1,2,3,\ldots,m$$

$$\vartheta_1 = 0.314, \vartheta_2 = 0.3276, \vartheta_3 = 0.3581$$

Table 7 proposed and existing Decision makers weights determination

	Proposed	Existing
ϑ_1	0.333168	0.314
ϑ_2	0.329349	0.3276
ϑ_3	0.337484	0.3581

present the weight determination

4. Calculate hybrid score accuracy matrix

In order to aggregate the hybrid score-accuracy values of the various decision makers' choices, the equation $\sum H_{ij}\,\vartheta_1$ used. and the following can be written as the overall hybrid score-accuracy matrix.

Hybrid score accuracy with $\sum H_{ij}\,\vartheta_1$ existing

$$\sum H_{ij}\,\vartheta_1 = \begin{bmatrix} .199 & .199 & .523 & .199 & .298 \\ .298 & .004 & .199 & .199 & .052 \\ .199 & .523 & .199 & .052 & .199 \end{bmatrix}$$

$$\sum H_{ij}\,\vartheta_2 = \begin{bmatrix} .311 & .207 & .207 & .207 & .054 \\ .207 & .311 & .054 & .207 & .207 \\ .207 & .311 & .005 & .207 & .054 \end{bmatrix}$$

$$\sum H_{ij}\,\vartheta_3 = \begin{bmatrix} .226 & .226 & .340 & .316 & .265 \\ .340 & .226 & .226 & .226 & .059 \\ .226 & .340 & .059 & .059 & .227 \end{bmatrix}$$

Hybrid score accuracy with $\sum H_{ij}\,\vartheta_1$ proposed

$$\sum H_{ij}\,\vartheta_1 = \begin{bmatrix} .270 & .204 & .229 & .270 & .259 \\ .323 & .203 & .093 & .141 & .312 \\ .270 & .259 & .167 & .162 & .273 \end{bmatrix}$$

$$\sum H_{ij}\,\vartheta_2 = \begin{bmatrix} .319 & .130 & .185 & .267 & .201 \\ .267 & .168 & .286 & .319 & .185 \\ .267 & .168 & .286 & .319 & .200 \end{bmatrix}$$

$$\sum H_{ij}\,\vartheta_3 = \begin{bmatrix} .274 & .206 & .232 & .274 & .172 \\ .327 & .133 & .189 & .274 & .206 \\ .274 & .172 & .293 & .327 & .133 \end{bmatrix}$$

Sum of the hybrid score accuracy matrix existing method

$$Sum\,of\ hybrid\ score\ matrix\ = \begin{bmatrix} .737 & .633 & .600 & .722 & .618 \\ .846 & .543 & .480 & .633 & .319 \\ .633 & .703 & .430 & .319 & .480 \end{bmatrix}$$

hybrid score accuracy in proposed methods

$$Sum\,of\ hybrid\ score\ matrix\ = \begin{bmatrix} .864 & .541 & .646 & .812 & .634 \\ .918 & .505 & .569 & .735 & .704 \\ .813 & .601 & .748 & .809 & .607 \end{bmatrix}$$

4.1 Weight model for criteria

Assume that the information about criteria weights is incompletely known given as follows: weight vectors,

Using the linear programming model Weighted criterion model

Assume that the following criteria weights information is incompletely known: weight matrices,

the linear programming paradigm

model $Max\ \omega = \frac{1}{n}\sum_{j=1}^{m} \omega_j H_{ij}$, we obtain the weight vector of the criteria as ω =[0.3 0.6 0.25 0.2 0.15].

We calculate the over all hybrid score-accuracy values

$\emptyset(m_i), i = 1,2,3,$in table 34 and 35 weighted criterion methods in exixting and proposed values

$$weight\ existing\ model\,matrix\ = \begin{bmatrix} .221 & .380 & .150 & .144 & .092 \\ .254 & .325 & .120 & .126 & .047 \\ .190 & .422 & .108 & .063 & .072 \end{bmatrix}$$

$$weight\,proposed\ \ model\,matrix\ = \begin{bmatrix} .259 & .324 & .161 & .162 & .095 \\ .275 & .303 & .142 & .147 & .105 \\ .243 & .360 & .187 & .161 & .091 \end{bmatrix}$$

$$\emptyset(m_1) = 0.9558, \emptyset(m_2) = 0.8772, \emptyset(m_3) = 0.8562$$

Table: 8 weight model criteria value

	Proposed	Existing
$\emptyset(m_1)$	1.003304	0.9558
$\emptyset(m_2)$	0.973961	.8772
$\emptyset(m_3)$	1.044839	0.8562

Table: 9 comparisons on Proposed and existing

Proposed model	$\emptyset(m_1) > \emptyset(m_2) > \emptyset(m_3)$
Existing model	$\emptyset(m_1) > \emptyset(m_2) > \emptyset(m_3)$

Fig 1 and fig 2 shows the pictorial representation of the values.

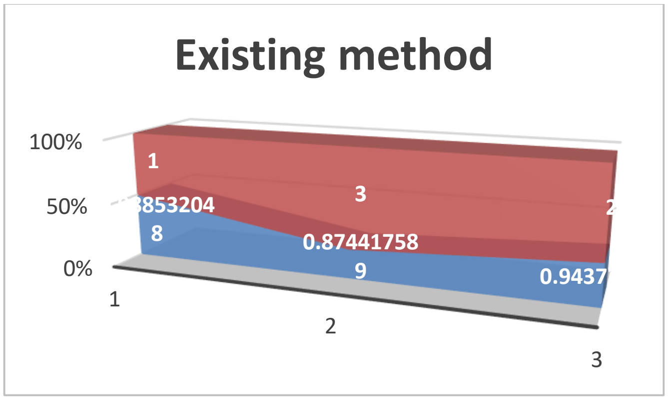

Fig 1 Existing method

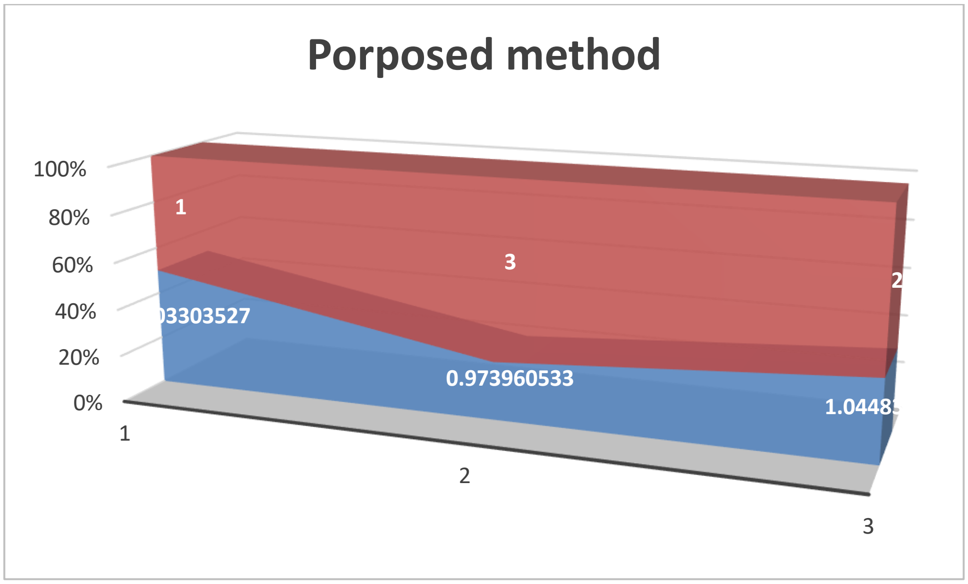

Fig 2 Proposed methods

5. Advantages and Limitation on various sets.

The table 10 below illustrates how different types of sets can manage different conditions or significant scenarios in relation to practical problems, as well as how they can't.

Table 10 limitation and drawback on various sets

Various Set Types	**Advantages**	**Limitations**
Crisp sets	can make an accurate determination without hesitating	unable to fully express the ambiguous information
Fuzzy sets	can explain the ambiguous information	Uncertain Information cannot be described with a non-membership degree.
Interval valued fuzzy sets	able to cope with interval data rather than exact data	Uncertain Information cannot be handled at the non-membership level.
Intuitionistic fuzzy sets	can simultaneously represent the uncertain information using degrees of membership (MS) and non-membership (NMS)	Cannot describe the sum of more than one MS and NMS degree.

Interval valued Intuitionistic fuzzy sets	ability to work with interval data	Cannot depict the sum of the MS and NMS degrees as greater than 1
Vague sets	can simultaneously explain ambiguous information with MS and NMS grades.	Cannot describe a degree sum of more than one in MS and NMS.
Pythagorean fuzzy sets	It provides sufficient room to discuss the total of MS and NMS degrees that is larger than 1.	cannot describe anything greater than the square of the MS and NMS degrees.
Interval valued Pythagorean fuzzy sets	dealing with interval data	undefined square sum of MS and NMS degrees higher than 1
Neutrosophic Sets	able to deal with data uncertainty and thoroughly acquire the optimum solution.	incapable of handling interval data
Interval valued Neutrosophic sets	able to handle the interval data's indeterminacy and produce the optimal solution.	unable to handle weight information that is incomplete

6. Conclusion

In this paper, the score function is used to evaluate the concept of a single valued Neutrosophic set used with the best 3D printers. Using the use of SVNS, a potential application has been addressed. This will not only be helpful on its own, but will also assist motivated researchers in resolving other uncertainty-related problems through comparative techniques. Based on actual decision-making challenges, the following paper illustrates a novel method for solving Neutrosophic fuzzy sets with the contraction value. This process has proven to be quite practical in many real-world situations where goal-oriented decision-making is required. In this paper, we model the problem of choosing the best 3D printer using the score and accuracy function, hybrid score-accuracy function of SVNNs, and linguistic variables in a single-valued Neutrosophic environment, where the weight of the decision makers is completely unknown and the weights of criteria are only partially known. From the analysis the proposed method is best for decision making. Future the work is extended to Plithogenic sets.

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