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Advanced T2NN-Taxonomy Framework for Assessing Quality of Dynamic Logos in Digital Media via Type-2 Neutrosophic Multi-Criteria Decision Analysis

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Abstract: In the context of digital media, the quality evaluation of dynamic logo design focuses on visual impact, brand communication, technical execution, and user experience. Visual impact assesses the logo's appeal and creativity; brand communication examines if the logo accurately reflects the brand image; technical execution looks at animation smoothness and cross-platform compatibility; user experience measures interactivity and memorability. These factors ensure the logo's effectiveness and influence in a digital environment. The evaluation of dynamic logo design quality within the digital media context is Multi-Criteria Decision Analysis (MCDA). Recently, the Taxonomy technique was described to grapple with MCDA. The Type-2 neutrosophic sets (T2NSs) are described as technique for characterizing fuzzy data during the evaluation of dynamic logo design quality within the digital media context. In this study, Taxonomy is described for MCDA under T2NSs. Then, the type-2 neutrosophic number T2NN (T2NN-Taxonomy) technique is described for MCDA. Finally, numerical example for evaluation of dynamic logo design quality within the digital media context is described to show the T2NN-Taxonomy technique. The key contribution of this research is described: (1) the novel MCDA technique is described based on Taxonomy technique with T2NN; (2) The new MCDA technique based on T2NN-Taxonomy technique is described for evaluation of dynamic logo design quality within the digital media context; (3) numerical example for evaluation of dynamic logo design quality within the digital media context and some comparative analysis is described to verify the T2NN-Taxonomy technique.

Keywords: Multi-Criteria Decision Analysis (MCDA); Type-2 neutrosophic sets (T2NSs); T2NN-Taxonomy; evaluation of dynamic logo design quality

1. Introduction

Digital technology is a new means of artistic creation, which not only promotes innovation in design approaches and media, but also continuously enriches design concepts, expands the scope of modern art, and enhances the passion for creation [1, 2]. Digital technology can allow designers to showcase more works and unleash their imagination. Especially in the post image era, designers can use a series of modern design approaches, such as digital media technology, to create a virtual environment, allowing various possibilities of contemporary art to be realized, thereby enriching the connotation of contemporary art and enriching the presentment dimensions of contemporary art [3, 4]. In design, in order to better express the exhibition objectives, convey artistic messages, convey concepts, and play its unique role [3-6]. This relatively limited medium and mode of communication is not applicable to modern art. The innovation of information technology has promoted the presentment of the art industry, enriched the art categories, improved the forms of expression of artistic ideas, expanded the audience, expanded the means and channels of communication, and liberated the constraints of old media on art [7]. Nowadays, the combination and presentment of knowledge economy and various social activities have led to a change in people's understanding of artistic works [8, 9]. The concept of art courses has also undergone a change, from the past single dimensional narrative teaching to a multidimensional and multi-level teaching approach. In the context of art socialization, designers use advanced approaches and technologies such as graphic transmission, virtual reality, and real-time interaction to more accurately convey design ideas and culture to the public, enabling them to better participate in their own creations and thereby increase their participation in art works [10]. Through the interaction between designers and users, audiences can present a sense of presence and participation, which can effectively stimulate users' creativity. Designers can also receive immediate feedback and feedback from users [11]. The rise of digital art design not only greatly affects traditional art design, but also provides new ideas for the presentment of art design [12, 13]. This pattern form enriches the connotation expression of artistic works. With the presentment of network technology, digital based art creation has been widely promoted, making traditional art creation more artistic [14, 15]. With the rapid presentment of technology, digital art design is becoming increasingly contemporary [16, 17]. The rise of digital technology in art design has led to a deeper understanding of people's needs for art works. Based on this, the created works not only reflect the characteristics of the times, but also accurately grasp the needs of real life and consumers, and fully showcase the works themselves in various ways [18-20]. Therefore, the authenticity and artistry of the works have been significantly improved [21, 22]. In the process of digitization, studying how digital art design impacts conventional art design is of great practical value. It can combine conventional design approaches with the advantages of digitization to improve the effectiveness of design and promote the good and fast presentment of art design in China [23, 24].

The evaluation of dynamic logo design quality within the digital media context is MCDA. Currently, Taxonomy [25-28] was described to grapples with MCDA. The T2NSs [29] are described as technique for characterizing fuzzy data during evaluation of dynamic logo design quality within the digital media context. Therefore, the T2NN-Taxonomy approach is described to grapple with the MCDA. Finally, numerical examples for evaluation of dynamic logo design quality within the digital media context and comparative analysis is described to grapple with T2NN-Taxonomy. The key research motivation of this work is described: (1) novel MCDA is described based on Taxonomy technique under T2NNs; (2) T2NN-Taxonomy is described to grapple with MCDA for evaluation of dynamic logo design quality within the digital media context; (3) numerical example for evaluation of dynamic logo design quality within the digital media context and comparative analysis are described to validate the T2NN-Taxonomy.

This paper is structured as follows: Section 2 introduces the T2NN-Taxonomy technique developed for multi-criteria decision analysis (MCDA). Section 3 outlines the criteria used in the evaluation process. Section 4 presents the application of the proposed method for assessing the quality of dynamic logo design within the digital media context, along with a comparative analysis of the results. Finally, the study concludes in Section 5.

2. Development of multi-criteria decision-making models

This section introduces some definitions of T2NNs and the proposed method [27] as:

Definition 1

T2NN can be defined as

$$Y = \{(x, T_Y(x), I_Y(x), F_Y(x)) \mid x \in X\} \tag{1}$$

$$T_Y(x) = \left(T_{T_Y}(x), T_{I_Y}(x), T_{F_Y}(x)\right) \quad (2)$$

$$I_Y(x) = \left(I_{T_Y}(x), I_{I_Y}(x), I_{F_Y}(x)\right) \quad (3)$$

$$F_Y(x) = \left(F_{T_Y}(x), F_{I_Y}(x), F_{F_Y}(x)\right) \quad (4)$$

$$T_Y(x) = (\ T_Y^1(x), T_Y^2(x), T_Y^3(x)) \quad (5)$$

$$I_Y(x) = (\ I_Y^1(x), I_Y^2(x), I_Y^3(x)) \quad (6)$$

$$F_Y(x) = (\ F_Y^1(x), F_Y^2(x), F_Y^3(x)) \quad (7)$$

Where $T_Y(x), I_Y(x), F_Y(x) \to [0,1]$

Where $0 \leq\ T_Y^1(x) + I_Y^1(x) + F_Y^1(x) \leq 3$

Definition 2

Let two T2NNs as:

$$Y_1 = \left(\left(T_{T_{Y_1}}(x), T_{I_{Y_1}}(x), T_{F_{Y_1}}(x)\right), \left(I_{T_{Y_1}}(x), I_{I_{Y_1}}(x), I_{F_{Y_1}}(x)\right), \left(F_{T_{Y_1}}(x), F_{I_{Y_1}}(x), F_{F_{Y_1}}(x)\right)\right)$$

$$Y_2 = \left(\left(T_{T_{Y_2}}(x), T_{I_{Y_2}}(x), T_{F_{Y_2}}(x)\right), \left(I_{T_{Y_2}}(x), I_{I_{Y_2}}(x), I_{F_{Y_2}}(x)\right), \left(F_{T_{Y_2}}(x), F_{I_{Y_2}}(x), F_{F_{Y_2}}(x)\right)\right)$$

And their operations can be defined as:

$$Y_1 \oplus Y_2 = \left\{ \begin{array}{c} \begin{pmatrix} T_{T_{Y_1}}(x) + T_{T_{Y_2}}(x) - T_{T_{Y_1}}(x)T_{T_{Y_2}}(x), \\ T_{I_{Y_1}}(x) + T_{I_{Y_2}}(x) - T_{I_{Y_1}}(x)T_{I_{Y_2}}(x), \\ T_{F_{Y_1}}(x) + T_{F_{Y_2}}(x) - T_{F_{Y_1}}(x)T_{F_{Y_2}}(x) \end{pmatrix}, \\ \left(I_{T_{Y_1}}(x)I_{T_{Y_2}}(x), I_{I_{Y_1}}(x)I_{I_{Y_2}}(x), I_{F_{Y_1}}(x)I_{F_{Y_2}}(x)\right), \\ \left(F_{T_{Y_1}}(x)F_{T_{Y_2}}(x), F_{I_{Y_1}}(x)F_{I_{Y_2}}(x), F_{F_{Y_1}}(x)F_{F_{Y_2}}(x)\right) \end{array} \right\} \quad (8)$$

$$Y_1 \otimes Y_2 = \left\{ \begin{array}{c} \left(T_{T_{Y_1}}(x)T_{T_{Y_2}}(x), T_{I_{Y_1}}(x)T_{I_{Y_2}}(x), T_{F_{Y_1}}(x)T_{F_{Y_2}}(x)\right), \\ \begin{pmatrix} I_{T_{Y_1}}(x) + I_{T_{Y_2}}(x) - I_{T_{Y_1}}(x)I_{T_{Y_2}}(x), \\ I_{I_{Y_1}}(x) + I_{I_{Y_2}}(x) - I_{I_{Y_1}}(x)I_{I_{Y_2}}(x), \\ I_{F_{Y_1}}(x) + I_{F_{Y_{12}}}(x) - I_{F_{Y_1}}(x)I_{F_{Y_2}}(x) \end{pmatrix}, \\ \begin{pmatrix} F_{T_{Y_1}}(x) + F_{T_{Y_2}}(x) - F_{T_{Y_1}}(x)F_{T_{Y_2}}(x), \\ F_{I_{Y_1}}(x) + F_{I_{Y_2}}(x) - F_{I_{Y_1}}(x)F_{I_{Y_2}}(x), \\ F_{F_{Y_1}}(x) + F_{F_{Y_2}}(x) - F_{F_{Y_1}}(x)F_{F_{Y_2}}(x) \end{pmatrix} \end{array} \right\} \quad (9)$$

$$\varphi Y_1 = \left\{ \begin{array}{c} \begin{pmatrix} \left(1 - \left(1 - T_{T_{Y_1}}(x)\right)^{\varphi}\right), \\ \left(1 - \left(1 - T_{I_{Y_1}}(x)\right)^{\varphi}\right), \\ \left(1 - \left(1 - T_{F_{Y_1}}(x)\right)^{\varphi}\right) \end{pmatrix}, \\ \left(\left(I_{T_{Y_1}}(x)\right)^{\varphi}, \left(I_{I_{Y_1}}(x)\right)^{\varphi}, \left(I_{F_{Y_1}}(x)\right)^{\varphi}\right), \\ \left(\left(F_{T_{Y_1}}(x)\right)^{\varphi}, \left(F_{I_{Y_1}}(x)\right)^{\varphi}, \left(F_{F_{Y_1}}(x)\right)^{\varphi}\right) \end{array} \right\} \quad (10)$$

$$Y_1^{\varphi}=\left\{\begin{array}{c}\left(\left(\left(T_{T_{Y_1}}(x)\right)^{\varphi},\left(T_{I_{Y_1}}(x)\right)^{\varphi},\left(T_{F_{Y_1}}(x)\right)^{\varphi}\right)\right),\\ \left(\begin{pmatrix}\left(1-\left(1-I_{T_{Y_1}}(x)\right)^{\varphi}\right),\\ \left(1-\left(1-I_{I_{Y_1}}(x)\right)^{\varphi}\right),\\ \left(1-\left(1-I_{F_{Y_1}}(x)\right)^{\varphi}\right)\end{pmatrix}\right),\\ \left(\begin{pmatrix}\left(1-\left(1-F_{T_{Y_1}}(x)\right)^{\varphi}\right),\\ \left(1-\left(1-F_{I_{Y_1}}(x)\right)^{\varphi}\right),\\ \left(1-\left(1-F_{F_{Y_1}}(x)\right)^{\varphi}\right)\end{pmatrix}\right)\end{array}\right\} \tag{11}$$

Definition 3

The score function can be computed as:

$$S(Y_1)=\frac{1}{12}*\begin{pmatrix}8+\left(T_{T_{Y_1}}(x)+2*T_{I_{Y_1}}(x)+T_{F_{Y_1}}(x)\right)+\\ \left(I_{T_{Y_1}}(x)+2*I_{I_{Y_1}}(x)+I_{F_{Y_1}}(x)\right)+\\ \left(F_{T_{Y_1}}(x)+F_{I_{Y_1}}(x)+F_{F_{Y_1}}(x)\right)\end{pmatrix} \tag{12}$$

2.1 Taxonomy Method

The description of the Taxonomy method is:

Step 1. Build the decision matrix

$$Y=\begin{bmatrix}y_{11} & \cdots & y_{1n}\\ \vdots & \ddots & \vdots\\ y_{m1} & \cdots & y_{mn}\end{bmatrix}_{m\times n};i=1,\dots,m;j=1,\dots,n \tag{13}$$

Step 2. Compute the mean and standard deviation.

$$A_j=\frac{1}{m}\sum_{i=1}^{m}y_{ij} \tag{14}$$

$$S_j=\sqrt{\frac{1}{m}\sum_{i=1}^{m}\left(y_{ij}-A_j\right)^2} \tag{15}$$

Step 3. Build the standard matrix

We normalize the decision matrix as:

$$R_{ij}=\frac{y_{ij}-A_j}{S_j} \tag{16}$$

$$R=\begin{bmatrix}r_{11} & \cdots & r_{1n}\\ \vdots & \ddots & \vdots\\ r_{m1} & \cdots & r_{mn}\end{bmatrix}_{m\times n} \tag{17}$$

Step 4. Compute the composite distance

The composite distance is computed of each alternative from the other alternative:

$$U_{ab}=\sqrt{\sum_{j=1}^{n}\left(r_{aj}-r_{Bj}\right)^2} \tag{18}$$

The pairwise comparison matrix is built between each alternative.

$$U=\begin{bmatrix}u_{11} & \cdots & u_{1n}\\ \vdots & \ddots & \vdots\\ u_{m1} & \cdots & u_{mn}\end{bmatrix}_{m\times n} \tag{19}$$

Step 5. Compute the homogeneity of alternatives.

The mean and standard deviation are computed for each alternative in the pairwise comparison matrix as:

$$Q = \frac{1}{m}\sum_{i=1}^{m} u_i \tag{20}$$

$$S_Q = \sqrt{\frac{1}{m}\sum_{i=1}^{m} (u_i - Q)^2} \tag{21}$$

$$T = Q \pm 2S_Q \tag{22}$$

Step 6. Compute the development pattern

$$U_{iq} = \sqrt{\sum_{j=1}^{n}\left(r_{aj} - r_{bj}\right)^2} \tag{23}$$

Step 7. Rank the alternatives

$$U_Q = U_{iq} \pm 2S_{U_{iq}} \tag{24}$$

$$D_i = \frac{U_{iq}}{U_q} \tag{25}$$

3. Development Criteria

Dynamic logo design in the digital media context requires careful consideration of multiple factors to ensure quality and effectiveness. This section outlines 16 key criteria for evaluating the quality of dynamic logos, focusing on their visual appeal, functionality, adaptability, and user experience. These criteria are crucial for designing logos that resonate with target audiences and perform well across various digital platforms as shown in Table 1.

Table 1. Key Criteria for Quality Evaluation of Dynamic Logo Design

No.	Criteria	Description
1	Visual Appeal	The aesthetic quality of the dynamic logo, including balance, contrast, and overall attractiveness.
2	Brand Identity Representation	The effectiveness of the logo in reflecting the values, vision, and personality of the brand.
3	Adaptability to Different Platforms	The ability of the logo to function seamlessly across various digital platforms.
4	Memorability	The capacity of the logo to create a lasting impression and be easily recognizable by users.
5	Animation Quality	Smoothness, creativity, and technical precision in the motion elements of the logo.
6	User Engagement	The extent to which the dynamic logo captures and holds the attention of users.
7	Consistence with Brand Guidelines	Adherence to the brand's established visual and stylistic guidelines.
8	Originality and Creativity	Uniqueness and innovation in the concept and execution of the dynamic logo.
9	Scalability	The logo's ability to maintain its quality and integrity when resized or displayed on various screen sizes.
10	Functionality in Motion	The practical effectiveness of the motion design in conveying the intended message or emotion.

11	Relevance to Target Audience	Alignment of the logo's style and message with the preferences and cultural values of the target audience.
12	Technical Compatibility	Compatibility of the logo format with various digital tools, software, and platforms.
13	Usability in Static and Dynamic Forms	Flexibility for the logo to work effectively as both a static image and a dynamic animation.
14	Color Harmony	Effective use of colors to evoke desired emotions and ensure accessibility for all users.
15	Design Simplicity	Clarity and minimalism in design without compromising on functionality or aesthetics.
16	Loading Speed	The time required for the dynamic logo to load, ensuring a smooth user experience.

These criteria provide a comprehensive framework for assessing dynamic logos, ensuring they meet both aesthetic and functional requirements in the digital era. By adhering to these guidelines, designers can create logos that are visually compelling, technically sound, and aligned with brand values.

Table 2. Summary of T2NNs Data

	A_1	A_2	A_3	A_4	A_5	A_6	A_7
C_1	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))
C_2	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))
C_3	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))
C_4	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))
C_5	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))
C_6	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))
C_7	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))
C_8	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))
C_9	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))
C_{10}	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))
C_{11}	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))
C_{12}	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))
C_{13}	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))
C_{14}	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))
C_{15}	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))
C_{16}	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))
	A_1	A_2	A_3	A_4	A_5	A_6	A_7
C_1	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))
C_2	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))
C_3	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))
C_4	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))
C_5	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))
C_6	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))
C_7	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))
C_8	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))
C_9	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))
C_{10}	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))
C_{11}	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))
C_{12}	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))
C_{13}	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))
C_{14}	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))
C_{15}	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))
C_{16}	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))
	A_1	A_2	A_3	A_4	A_5	A_6	A_7
C_1	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))
C_2	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))
C_3	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))
C_4	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))
C_5	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))
C_6	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))
C_7	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))
C_8	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))
C_9	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))
C_{10}	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))
C_{11}	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))
C_{12}	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))
C_{13}	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))
C_{14}	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))
C_{15}	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))
C_{16}	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))

4. Application for evaluation of dynamic logo design quality within the digital media context

This section demonstrates the results of the proposed method for evaluating the quality of dynamic logo designs. Seven dynamic logo design schemes were assessed based on 16 attributes. The evaluation process consisted of several structured steps, each contributing to a comprehensive and objective ranking of alternatives.

Step 1: Building the Decision Matrix

In Step 1, Eq. (13) was applied to construct the decision matrix, as shown in Table 2. The score function was then used to obtain crisp values, and the resulting matrices were combined into one. The criteria weights were subsequently computed as follows: C1 = 0.062582551, C2 = 0.062981634, C3 = 0.063375707, C4 = 0.063238784, C5 = 0.060884361, C6 = 0.061380293, C7 =

0.0613201, C8 = 0.06255583, C9 = 0.063504282, C10 = 0.063718017, C11 = 0.063971827, C12 = 0.060089535, C13 = 0.062131704, C14 = 0.061757668, C15 = 0.063576084, and C16 = 0.06293154.

Step 2: Computing the Mean and Standard Deviation

the mean and standard deviation for each criterion were computed using Eqs. (14) and (15).

Step 3: Normalizing the Decision Matrix

The decision matrix was normalized using Eq. (16) to ensure consistency and comparability across all criteria. This step standardized the data, enabling a fair evaluation of alternatives.

Step 4: Computing Composite Distance

The composite distance for each alternative was calculated using Eq. (16). This step quantified the relative performance of each dynamic logo design in relation to the established criteria.

Step 5: Evaluating Homogeneity of Alternatives

Homogeneity of alternatives was assessed using Eqs. (20) and (21). This analysis provided insights into the consistency and balance of the dynamic logo designs.

Step 6: Determining the Development Pattern

Using Eq. (23), the development pattern for each alternative was identified. This step revealed potential improvement trajectories for designs.

Step 7: Ranking the Alternatives

Based on the comprehensive analysis, the alternatives were ranked as follows:

A7 > A1 > A6 > A2 > A4 > A5 > A3

Alternative A7 emerged as the best-performing dynamic logo design, showcasing superior alignment with the evaluation criteria. Conversely, A3 ranked the lowest, indicating areas for significant improvement. The rankings of the alternatives are summarized in Figure 1, which clearly illustrates the performance scores of each alternative.

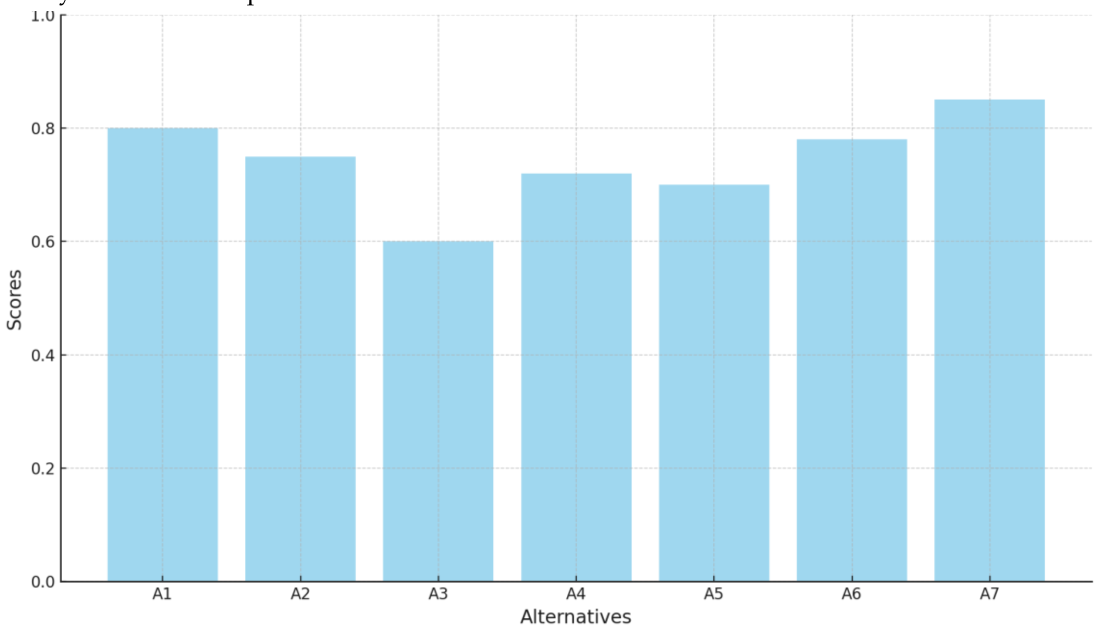

Figure 1: Ranking of Alternatives Based on Evaluation Criteria

4.1 Performance Analysis of Alternatives

The rankings of the dynamic logo design alternatives were influenced by several key factors derived from the evaluation criteria. Alternative A7 stood out as the best-performing design due to its exceptional adaptability to various platforms, high memorability, and superior animation quality. Its ability to engage users effectively and maintain technical precision in its motion elements contributed significantly to its top position. While it excelled in most areas, slight improvements in loading speed could make it even better.

Alternative A1 demonstrated strong brand identity representation and consistent adherence to brand guidelines, making it a reliable choice. Its scalability across different screen sizes further strengthened its performance. However, it showed moderate creativity compared to A7, which limited its ranking.

Alternative A6 performed well in aligning with the preferences and cultural values of the target audience. It also showed effective use of color harmony, creating a visually appealing design. Despite these strengths, it struggled with the practical functionality of its motion design, which slightly impacted on its overall ranking.

In contrast, Alternative A3 ranked the lowest, primarily due to its lack of visual appeal and memorability. It failed to adapt effectively to various platforms, and its slower loading speed hindered its usability. While it had a simplistic and technically compatible design, these factors were insufficient to elevate its ranking among the alternatives.

The performance analysis highlights the strengths and weaknesses of each alternative, providing valuable insights into refining dynamic logo designs. By addressing the identified shortcomings, designers can enhance the quality and effectiveness of their work, ensuring alignment with both technical requirements and user expectations.

4.2 Comparative analysis

The T2NN- Taxonomy technique is compared with distance measures under T2NN. The comparative results are described in Table 3.

Table 3. Order for different techniques

Techniques	Order
T2NN- VIKOR technique	A7>A6>A1>A2>A5>A4>A3
T2NN- TOPSIS technique	A7>A2>A6>A1>A4>A5>A3
T2NN- EDAS technique	A7>A1>A4>A6>A2>A5>A3
T2NN- Taxonomy technique	A7>A1>A6>A2>A4>A5>A3

Based on comparative analysis, the ranking order of the existing techniques is the same as the order produced by the T2NN- Taxonomy technique. This suggests that the ranking order of the various techniques is consistent, which verifies the rationality and effectiveness of the T2NN- Taxonomy approach. The key advantages of T2NN- Taxonomy technique is summarized: (1) T2NN- Taxonomy technique not only addresses the uncertainty inherent in MCDA problems, but also incorporates psychological behavioral factors; (2) T2NN- Taxonomy approach effectively combines and describes the behavior of Taxonomy and average methods when applied to MCDA.

4.3 Sensitivity Analysis

In this part we change the parameter values in the T2NN- Taxonomy methodology to show the stability of the rank under different cases. As is Eqs. (24 and 25) we change the parameter to plus and mins into four cases. Then we rank the alternatives. The results show the rank of alternatives is stable in different cases. The rank of alternatives is shown in Table 4.

Table 4. Order for different cases

Cases	Order
Case 1	A7>A6>A1>A2>A5>A4>A3
Case 2	A7>A2>A6>A1>A4>A5>A3
Case 3	A7>A1>A4>A2>A6>A5>A3
Case 4	A7>A1>A6>A6>A2>A5>A3

5. Conclusion

In the digital media landscape, evaluating the quality of dynamic logo design is crucial for several reasons. Firstly, it ensures that the logo effectively captures and retains audience attention, which is vital for brand recognition. A well-designed dynamic logo can convey a brand's identity and values clearly, enhancing its image and consistency across platforms. Additionally, quality evaluation helps optimize technical performance, ensuring smooth animations that are compatible with various devices and platforms. This is essential for maintaining seamless user experience. Furthermore, by assessing user engagement, brands can create logos that foster interaction and leave a lasting impression. Overall, this evaluation strengthens brand presence and effectiveness in the digital space. The evaluation of dynamic logo design quality within the digital media context is MCDA. Consequently, the T2NN- Taxonomy technique is described to grapple with MCDA for evaluation of dynamic logo design quality within the digital media context. The key contribution of this research is described: (1) the novel MCDA is described based on Taxonomy and average technique under T2NN; (2) The objective weights are described through average technique; (3) The new MCDA technique based on T2NN- Taxonomy technique is described for evaluation of dynamic logo design quality within the digital media context; (4) numerical example for evaluation of dynamic logo design quality within the digital media context and comparative analysis are described to validate the T2NN-Taxonomy.

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