Modified TOPSIS Method for Neutrosophic Cubic Number Multi-Attribute Decision-Making and Applications to Music Composition Effectiveness Evaluation of Film and Television

Liang Yang*, Jun Zhao
Anhui Broadcasting and Television Vocational and Technical College, Hefei, 230011, Anhui, China

Abstract*—Contemporary music composition for film and television has exhibited a trend towards diversification, which is reflected in various aspects such as the diversity of musical styles, the integration of music and visuals, as well as the technical means of music creation. With the continuous advancement of music production technology and film/television production technology, the creation of music for film and television has increasingly emphasized the organic integration of music and visuals, as well as the role of music in emotional expression and atmosphere creation. Meanwhile, the fusion and innovation of different musical styles have also brought more possibilities and space to the creation of music for film and television. This trend of diversification not only enriches the artistic expressiveness of film and television works, but also provides audiences with a more diverse audiovisual experience. The music composition effectiveness evaluation of film and television is multi-attribute decision-making (MADM) problem. In this paper, the TOPSIS method is extended to the framework of neutrosophic cubic sets (NCSs) to address MADM problems. The CRITIC method is employed to obtain the weights of the attributes, ensuring a systematic and objective approach to determining their relative importance. Furthermore, the neutrosophic cubic number TOPSIS (NCN-TOPSIS) approach is established for MADM scenarios. To demonstrate the applicability of the proposed NCN-TOPSIS model, a numerical example focused on the music composition effectiveness evaluation in film and television is presented. Additionally, comparative analyses are conducted to showcase the advantages of the NCN-TOPSIS approach over other decision-making methods. By extending the TOPSIS technique to the NCSs environment and integrating the CRITIC method, this research contributes to the field of MADM by providing a robust and efficient decision-making tool for complex, multi-criteria problems, as exemplified by the music composition evaluation in the film and television industry.

***Keywords*—Multi-Attribute Decision-Making (MADM); NCSs; TOPSIS approach; music composition effectiveness evaluation**

I. INTRODUCTION

The development of contemporary music production technology has had a profound impact on film and television music creation [1, 2]. With the progress of technology, music production tools and techniques have been continuously updated, providing more possibilities and innovative space for film and television music creation. These technologies not only improve the efficiency and quality of music production, but also make the integration of music and visuals more intimate and natural [3, 4]. The continuous advancement and innovation of technological means is undoubtedly a key driving force in promoting the sustained prosperity of film and television music creation. As music production technology evolves rapidly, film and television music creation is gradually breaking free from traditional constraints and showcasing unprecedented creativity and imagination [5, 6]. Modern music production technology not only provides more convenient creation and editing tools, but also enables composers to easily explore the integration of various timbres and styles, creating unique and highly engaging musical works. The widespread application of these technological means not only enriches the connotation and extension of film and television music creation, but also, while driving the innovative development of film and television music, brings more diversified and personalized audiovisual experiences to the audience [7, 8]. Therefore, we must fully recognize the important role of technological means in film and television music creation, and continue to promote their progress and innovation, contributing to the flourishing development of film and television music art [9]. In contemporary film and television music creation, the phenomenon of musical style integration not only showcases the infinite possibilities of art, but also becomes a vivid manifestation of cultural exchange and collision [10, 11]. Against the backdrop of globalization, the mutual penetration and integration of different cultures and music styles have provided a vast space for innovation in film and television music composition [12-14]. With an open mindset and unique perspectives, composers skillfully blend elements of classical elegance, popular vernacular, rock passion, and avant-garde electronics, breaking the boundaries of traditional music styles and creating film and television music works that have both depth and breadth [15, 16]. This cross-border integration of musical styles has greatly enriched the expressiveness and emotional depth of film and television music, allowing audiences to experience the unique charm of music and audiovisual art, and enjoy an unprecedented visual and auditory feast [17-19]. This integration phenomenon not only drives the progress of film and television music creation, but also further promotes the exchange and understanding between different cultures, demonstrating the power and allure of art [20-22].

MADM is a branch of decision theory that focuses on making decisions when there are multiple, often conflicting,

---

*Corresponding Author.

attributes or objectives that need to be taken into account [23-27]. These attributes can be both quantitative (e.g., cost, performance) and qualitative (e.g., aesthetic appeal, brand reputation) in nature [28-32]. The goal of MADM is to help DMs systematically evaluate the available alternatives and make an informed choice that best aligns with their preferences and priorities. MADM has a wide range of applications across various domains, including product design, resource allocation, policy making, and personal decision-making. For example, in the context of urban planning, MADM can be used to evaluate and prioritize infrastructure projects based on factors such as cost, environmental impact, accessibility, and economic benefits [33-37].

The evaluation of music composition effectiveness in film and television is often considered a MADM problem. However, the existing literature lacks research on the application of the TOPSIS method [38, 39] for MADM in this domain under NCNs [40]. Given the importance of MADM in various real-world applications, including the music composition effectiveness evaluation of film and television, it is essential to further explore the use of the TOPSIS method under NCNs environments. The primary objective of this study is to develop a novel technique that could more efficiently solve certain MADM problems using the NCN-TOPSIS approach. The key highlights of this work are illustrated: (1) The CRITIC technique is illustrated for the weights of the attributes; (2) The NCN-TOPSIS technique is defined and formalized for decision-making under NCNs; (3) numerical example focusing on the music composition effectiveness evaluation of film and television is illustrated the application of the NCN-TOPSIS approach. Comparative analyses are conducted to showcase the decision-making advantages of the proposed NCN-TOPSIS approach. By addressing the gap in the existing literature and proposing a novel NCN-TOPSIS method, this research aims to contribute to the field of MADM, particularly in the context of film and television music composition evaluation and other relevant domains. The demonstrated application of the NCN-TOPSIS method in the labor education context further highlights its potential for solving complex decision-making issues involving multiple, often conflicting, attributes.

The remainder of this paper is structured as follows: Section II introduces the NCSs, providing the necessary background for the proposed approach. Section III illustrates several fused operators of NCSs, which are essential for the development of the decision-making method. In Section IV, the NCN-TOPSIS approach is devised for MADM. It provides an empirical example focusing on the music composition effectiveness evaluation of film and television. This section demonstrates the application of the NCN-TOPSIS method and includes comparative analyses to highlight the decision-making advantages of the proposed approach. Finally, Section V draws a satisfactory conclusion to the study.

II. PRELIMINARIES

Ail et al. [40] illustrated the NCSs in light with SVNSs [41] and IVNSs [42].

Definition 1 [40]. The NCSs is illustrated:

$$UA=\left\{\left(x,\left(UR_A\left(x\right),US_A\left(x\right)\right)\right)\middle|x\in X\right\} \tag{1}$$

where $UR_A\left(x\right)$ is IVNSs and $US_A\left(x\right)$ is SVNSs.

$$UR_A\left(x\right)=\begin{pmatrix}\left[UT_A^L\left(x\right),UT_A^R\left(x\right)\right],\\ \left[UI_A^L\left(x\right),UI_A^R\left(x\right)\right],\\ \left[UF_A^L\left(x\right),UF_A^R\left(x\right)\right]\end{pmatrix} \tag{2}$$

$$US_A\left(x\right)=\left(UT_A\left(x\right),UI_A\left(x\right),UF_A\left(x\right)\right) \tag{3}$$

$$\begin{gathered}\left[UT_A^L\left(x\right),UT_A^R\left(x\right)\right],\left[UI_A^L\left(x\right),UI_A^R\left(x\right)\right],\\ \left[UF_A^L\left(x\right),UF_A^R\left(x\right)\right]\subseteq\left[0,1\right]\end{gathered} \tag{4}$$

$$UT_A\left(x\right),UI_A\left(x\right),UF_A\left(x\right)\in\left[0,1\right] \tag{5}$$

$$\begin{gathered}0\le UT_A^R\left(x\right)+UI_A^R\left(x\right)+UF_A^R\left(x\right)\le 3,\\ 0\le UT_A\left(x\right)+UI_A\left(x\right)+UF_A\left(x\right)\le 3\end{gathered} \tag{6}$$

The neutrosophic cubic number (NCN) is illustrated as:

$$UA=\left\{\begin{matrix}\left(\left[UT_A^L,UT_A^R\right],\left[UI_A^L,UI_A^R\right],\left[UF_A^L,UF_A^R\right]\right),\\ \left(UT_A,UI_A,UF_A\right)\end{matrix}\right\}.$$

Definition 2[40]. Let $UA=\left\{\begin{matrix}\left(\left[UT_A^L,UT_A^R\right],\left[UI_A^L,UI_A^R\right],\left[UF_A^L,UF_A^R\right]\right),\\ \left(UT_A,UI_A,UF_A\right)\end{matrix}\right\}$ and $UB=\left\{\begin{matrix}\left(\left[UT_B^L,UT_B^R\right],\left[UI_B^L,UI_B^R\right],\left[UF_B^L,UF_B^R\right]\right),\\ \left(UT_B,UI_B,UF_B\right)\end{matrix}\right\}$, the operations laws are illustrated:

$$(1)\ UA\oplus UB=\left\{\begin{matrix}\begin{pmatrix}\left(UT_A^L+UT_B^L-UT_A^LUT_B^L,UT_A^R+UT_B^R-UT_A^RUT_B^R\right),\\ \left[UI_A^LUI_B^L,UI_A^RUI_B^R\right],\left[UF_A^LUF_B^L,UF_A^RUF_B^R\right]\end{pmatrix},\\ \left(UT_A+UT_B-UT_AUT_B,UI_AUI_B,UF_AUF_B\right)\end{matrix}\right\};$$

$$(2)\ A\otimes B=\left\{\begin{array}{l}\left(\begin{array}{l}\left[UT_A^L UT_B^L, UT_A^R UT_B^R\right],\\ \left[UI_A^L+UI_B^L-UI_A^L UI_B^L, UI_A^R+UI_B^R-UI_A^R UI_B^R\right],\\ \left[UF_A^L+UF_B^L-UF_A^L UF_B^L, UF_A^R+UF_B^R-UF_A^R UF_B^R\right]\end{array}\right),\\ \left(UT_A UT_B, UI_A+UI_B-UI_A UI_B, UF_A+UF_B-UF_A UF_B\right)\end{array}\right\};$$

$$(3)\ \lambda UA=\left\{\left(\begin{array}{l}\left[1-\left(1-UT_A^L\right)^{\lambda}, 1-\left(1-UT_A^R\right)^{\lambda}\right],\\ \left[\left(UI_A^L\right)^{\lambda},\left(UI_A^R\right)^{\lambda}\right],\left[\left(UF_A^L\right)^{\lambda},\left(UF_A^L\right)^{\lambda}\right]\end{array}\right),\left(\begin{array}{l}1-\left(1-UT_A\right)^{\lambda},\\ \left(UI_A\right)^{\lambda},\left(UF_A\right)^{\lambda}\end{array}\right)\right\},\lambda>0;$$

$$(4)\ \left(UA\right)^{\lambda}=\left\{\left(\begin{array}{l}\left[\left(UT_A^L\right)^{\lambda},\left(UT_A^R\right)^{\lambda}\right],\\ \left[1-\left(1-UI_A^L\right)^{\lambda}, 1-\left(1-UI_A^R\right)^{\lambda}\right],\\ \left[1-\left(1-UF_A^L\right)^{\lambda}, 1-\left(1-UF_A^R\right)^{\lambda}\right]\end{array}\right),\left(\left(UT_A\right)^{\lambda}, 1-\left(1-UI_A\right)^{\lambda}, 1-\left(1-UF_A\right)^{\lambda}\right)\right\},\lambda>0.$$

Definition 3[43]. Let $UA=\left\{\begin{array}{l}\left(\left[UT_A^L,UT_A^R\right],\left[UI_A^L,UI_A^R\right],\left[UF_A^L,UF_A^R\right]\right),\\ \left(UT_A,UI_A,UF_A\right)\end{array}\right\}$, the NCN score values (NCNSV), NCN accuracy values (NCNAV), NCN certainty values (NCNCV) are illustrated:

$$NCNSV\left(UA\right)=\frac{\left(\begin{array}{l}6+UT_A^L+UT_A^R+UT_A-UI_A^L-\\ UI_A^R-UF_A^L-UF_A^R-UI_A-UF_A\end{array}\right)}{9}\tag{7}$$

$$NCNAV\left(UA\right)=\frac{\left(\begin{array}{l}UT_A^L+UT_A^R+UT_A-\\ UI_A^L-UI_A^R-UF_A\end{array}\right)}{3}\tag{8}$$

$$NCNCV\left(UA\right)=\frac{\left(UT_A^L+UT_A^R+UT_A\right)}{3}\tag{9}$$

Definition 4[43]. Let

$$UA=\left\{\begin{array}{l}\left(\left[UT_A^L,UT_A^R\right],\left[UI_A^L,UI_A^R\right],\left[UF_A^L,UF_A^R\right]\right),\\ \left(UT_A,UI_A,UF_A\right)\end{array}\right\}$$

and

$$UB=\left\{\begin{array}{l}\left(\left[UT_B^L,UT_B^R\right],\left[UI_B^L,UI_B^R\right],\left[UF_B^L,UF_B^R\right]\right),\\ \left(UT_B,UI_B,UF_B\right)\end{array}\right\}$$

, The comparison analysis for NCNs is illustrated:

1) if $NCNSV\left(UA\right)<NCNSV\left(UB\right)$, then, $UA<UB$;

2) if $NCNSV\left(UA\right)=NCNSV\left(UB\right)$, and $NCNAV\left(UA\right)<NCNAV\left(UB\right)$, then $UA<UB$;

3) if $NCNSV\left(UA\right)=NCNSV\left(UB\right)$ and $NCNAV\left(UA\right)=NCNAV\left(UB\right)$, and $NCNCV\left(UA\right)<NCNCV\left(UB\right)$, then, $UA<UB$;

4) if $NCNSV\left(UA\right)=NCNSV\left(UB\right)$ and $NCNAV\left(UA\right)=NCNAV\left(UB\right)$, and $NCNCV\left(UA\right)=NCNCV\left(UB\right)$, then, $UA=UB$.

Definition 5[44]. Let

$$UA=\left\{\begin{array}{l}\left(\left[UT_A^L,UT_A^R\right],\left[UI_A^L,UI_A^R\right],\left[UF_A^L,UF_A^R\right]\right),\\ \left(UT_A,UI_A,UF_A\right)\end{array}\right\}$$

and

$$UB=\left\{\begin{array}{l}\left(\left[UT_B^L,UT_B^R\right],\left[UI_B^L,UI_B^R\right],\left[UF_B^L,UF_B^R\right]\right),\\ \left(UT_B,UI_B,UF_B\right)\end{array}\right\}$$

, then the NCN Euclid distance (NCNED) is illustrated:

$$NCNED\left(A,B\right)=\sqrt{\frac{1}{9}\left(\begin{array}{l}\left|UT_A^L-UT_B^L\right|^2+\left|UT_A^R-UT_B^R\right|^2+\left|UI_A^L-UI_B^L\right|^2+\\ \left|UI_A^R-UI_B^R\right|^2+\left|UF_A^L-UF_B^L\right|^2+\left|UF_A^R-UF_B^R\right|^2+\\ \left|UT_A-UT_B\right|^2+\left|UI_A-UI_B\right|^2+\left|UF_A-UF_B\right|^2\end{array}\right)}\tag{10}$$

III. NCN-TOPSIS Approach for MAGDM with NCSs

The NCN-TOPSIS approach is illustrated for MADM. Let $UY=\{UY_1,UY_2,\ldots,UY_m\}$ be alternatives. Let $UZ=\{UZ_1,UZ_2,\ldots,UZ_n\}$ be attributes, $uw=\{uw_1,uw_2,\ldots,uw_n\}$ be weight for UZ_j, $uw_j\in[0,1],\sum_{j=1}^{n}uw_j=1$. And

$$UQ=\left(UQ_{ij}\right)_{m\times n}=\left\{\begin{array}{l}\left(\begin{array}{l}\left[UT_{ij}^{L},UT_{ij}^{R}\right],\left[UI_{ij}^{L},UI_{ij}^{R}\right],\\ \left[UF_{ij}^{L},UF_{ij}^{R}\right]\end{array}\right),\\ \left(UT_{ij},UI_{ij},UF_{ij}\right)\end{array}\right\}_{m\times n}$$

is the NCN-matrix. Subsequently, NCN-TOPSIS method is illustrated for MADM.

Step 1. Normalize the $UQ=\left(UQ_{ij}\right)_{m\times n}$ to $NUQ=\left[NUQ_{ij}\right]_{m\times n}$.

$$NUQ_{ij}=\left\{\begin{array}{l}\left(\left[UT_{ij}^{NL},UT_{ij}^{NR}\right],\left[UI_{ij}^{NL},UI_{ij}^{NR}\right],\left[UF_{ij}^{NL},UF_{ij}^{NR}\right]\right),\\ \left(UT_{ij}^{N},UI_{ij}^{N},UF_{ij}^{N}\right)\end{array}\right\}$$
$$=\begin{cases}\left\{\begin{array}{l}\left(\left[UT_{ij}^{L},UT_{ij}^{R}\right],\left[UI_{ij}^{L},UI_{ij}^{R}\right],\left[UF_{ij}^{L},UF_{ij}^{R}\right]\right),\\ \left(UT_{ij},UI_{ij},UF_{ij}\right)\end{array}\right\}, & UZ_j \text{ is benefit criterion}\\ \left\{\begin{array}{l}\left(\left[UF_{ij}^{L},UF_{ij}^{R}\right],\left[1-UI_{ij}^{R},1-UI_{ij}^{L}\right],\left[UT_{ij}^{L},UT_{ij}^{R}\right]\right),\\ \left(UF_{ij},1-UI_{ij},UT_{ij}\right)\end{array}\right\}, & UZ_j \text{ is cost criterion}\end{cases} \tag{11}$$

Step 2. Illustrate the weight through CRITIC technique.

The CRITIC [45] is illustrated for the weights.

1) The NCN correlation coefficient numbers (NCNCCN) are illustrated.

$$NCNCCN_{jt}=\frac{\left(\sum_{i=1}^{m}\begin{array}{l}\left(NCNSV\left(NUQ_{ij}\right)-NCNSV\left(NUQ_{j}\right)\right)\\ \times\left(NCNSV\left(NUQ_{it}\right)-NCNSV\left(NUQ_{t}\right)\right)\end{array}\right)}{\left(\begin{array}{l}\sqrt{\sum_{i=1}^{m}\left(NCNSV\left(NUQ_{ij}\right)-NCNSV\left(NUQ_{j}\right)\right)^{2}}\\ \times\sqrt{\sum_{i=1}^{m}\left(NCNSV\left(NUQ_{it}\right)-NCNSV\left(NUQ_{t}\right)\right)^{2}}\end{array}\right)},$$
$$j,t=1,2,\ldots,n, \tag{12}$$

where

$$NCNSV\left(NUQ_{j}\right)=\frac{1}{m}\sum_{i=1}^{m}NCNSV\left(NUQ_{ij}\right),$$
$$NCNSV\left(NUQ_{t}\right)=\frac{1}{m}\sum_{i=1}^{m}NCNSV\left(NUQ_{it}\right)$$

2) Illustrate the NCN standard deviation numbers (NCNSDN).

$$NCNSDN_{j}=\sqrt{\frac{1}{m-1}\sum_{i=1}^{m}\left(NCNSV\left(NUQ_{ij}\right)-NCNSV\left(NUQ_{j}\right)\right)^{2}} \tag{13}$$

where $NCNSV\left(NUQ_{j}\right)=\frac{1}{m}\sum_{i=1}^{m}NCNSV\left(NUQ_{ij}\right)$.

3) Illustrate the weight information.

$$uw_{j}=\frac{NCNSDN_{j}\sum_{t=1}^{n}\left(1-NCNCCN_{jt}\right)}{\sum_{j=1}^{n}\left(NCNSDN_{j}\sum_{t=1}^{n}\left(1-NCNCCN_{jt}\right)\right)} \tag{14}$$

where $uw_j\in[0,1]$, $\sum_{j=1}^{n}uw_j=1$.

Step 3. Illustrate the NCN positive ideal solution (NCNPIS) and NCN negative ideal solution (NCNNIS):

$$NCNPIS=\left\{NCNPIS_{j}\right\},\ j=1,2,\ldots,n. \tag{15}$$

$$NCNNIS=\left\{NCNNIS_{j}\right\},\ j=1,2,\ldots,n. \tag{16}$$

$$NCNPIS_j = \left\{ \begin{array}{l} \left(\begin{array}{l} \left[UT_j^{NL+}, UT_{ij}^{NR+}\right], \left[UI_j^{NL+}, UI_j^{NR+}\right], \\ \left[UF_j^{NL+}, UF_j^{NR+}\right] \end{array} \right), \\ \left(UT_j^{N+}, UI_j^{N+}, UF_j^{N+}\right) \end{array} \right\} \tag{17}$$

$$NCNNIS_j = \left\{ \begin{array}{l} \left(\begin{array}{l} \left[UT_j^{NL-}, UT_{ij}^{NR-}\right], \left[UI_j^{NL-}, UI_j^{NR-}\right], \\ \left[UF_j^{NL-}, UF_j^{NR-}\right] \end{array} \right), \\ \left(UT_j^{N-}, UI_j^{N-}, UF_j^{N-}\right) \end{array} \right\} \tag{18}$$

$$\begin{array}{l} NCNPIS_j \\ = \max\limits_j NCNSV \left\{ \begin{array}{l} \left(\begin{array}{l} \left[UT_{ij}^{NL}, UT_{ij}^{NR}\right], \left[UI_{ij}^{NL}, UI_{ij}^{NR}\right], \\ \left[UF_{ij}^{NL}, UF_{ij}^{NR}\right] \end{array} \right), \\ \left(UT_{ij}^{N}, UI_{ij}^{N}, UF_{ij}^{N}\right) \end{array} \right\} \end{array} \tag{19}$$

$$\begin{array}{l} NCNNIS_j = \\ \min\limits_j NCNSV \left\{ \begin{array}{l} \left(\begin{array}{l} \left[UT_{ij}^{NL}, UT_{ij}^{NR}\right], \left[UI_{ij}^{NL}, UI_{ij}^{NR}\right], \\ \left[UF_{ij}^{NL}, UF_{ij}^{NR}\right] \end{array} \right), \\ \left(UT_{ij}^{N}, UI_{ij}^{N}, UF_{ij}^{N}\right) \end{array} \right\} \end{array} \tag{20}$$

Step 4. Illustrate the distances from NCNPIS and NCNNIS:

Step 5. Illustrate the NCN correlation coefficient (NCNCC) from NCNNIS:

$$NCNCC\left(UY_i\right) = \frac{NCNNISED\left(UY_i\right)}{NCNPISED\left(UY_i\right) + NCNNISED\left(UY_i\right)} \tag{23}$$

Step 6. In light with $NCNCC\left(UY_i\right)$. The highest $NCNCC\left(UY_i\right)$ is the optimal alternative.

$$\begin{array}{l} NCNPISED\left(UY_i\right) = \sum\limits_{j=1}^{n} uw_j NCNED\left(NUQ_{ij}, NCNPIS_j\right) \\ = \sum\limits_{j=1}^{n} uw_j \sqrt{\frac{1}{9} \left(\begin{array}{l} \left|UT_{ij}^{NL} - UT_j^{NL+}\right|^2 + \left|UT_{ij}^{RL} - UT_{ij}^{NR+}\right|^2 + \left|UI_{ij}^{NL} - UI_j^{NL+}\right|^2 + \\ \left|UI_{ij}^{NR} - UI_j^{NR+}\right|^2 + \left|UF_{ij}^{NL} - UF_j^{NL+}\right|^2 + \left|UF_{ij}^{NR} - UF_j^{NR+}\right|^2 + \\ \left|UT_{ij} - UT_j^{+}\right|^2 + \left|UI_{ij} - UI_j^{+}\right|^2 + \left|UF_{ij} - UF_j^{+}\right|^2 \end{array} \right)} \end{array} \tag{21}$$

$$\begin{array}{l} NCNNISED\left(UY_i\right) = \sum\limits_{j=1}^{n} uw_j NCNED\left(NUQ_{ij}, NCNNIS_j\right) \\ = \sum\limits_{j=1}^{n} uw_j \sqrt{\frac{1}{9} \left(\begin{array}{l} \left|UT_{ij}^{NL} - UT_j^{NL-}\right|^2 + \left|UT_{ij}^{RL} - UT_{ij}^{NR-}\right|^2 + \left|UI_{ij}^{NL} - UI_j^{NL-}\right|^2 + \\ \left|UI_{ij}^{NR} - UI_j^{NR-}\right|^2 + \left|UF_{ij}^{NL} - UF_j^{NL-}\right|^2 + \left|UF_{ij}^{NR} - UF_j^{NR-}\right|^2 + \\ \left|UT_{ij} - UT_j^{-}\right|^2 + \left|UI_{ij} - UI_j^{-}\right|^2 + \left|UF_{ij} - UF_j^{-}\right|^2 \end{array} \right)} \end{array} \tag{22}$$

IV. NUMERICAL EXAMPLE AND COMPARATIVE ANALYSIS

A. *Numerical Example*

Music for film and television, as an essential component of audiovisual works, not only adds emotional tones to the visuals, but also plays a crucial role in narrative, atmosphere creation, and audience emotional experiences. Through elements such as melody, rhythm, and timbre, it can interact with the visuals to jointly construct the unique atmosphere and emotional tonality of a work. In recent years, with the continuous advancement of technology and creative concepts, contemporary music composition for film and television has exhibited a trend towards diversification. The diversity of musical styles, the integration of music and visuals, as well as the innovation of technical means have all injected new vitality into music for film and television. In audiovisual works, the close integration of music and narrative often deepens the audience's emotional resonance. For example, in tense and exciting storylines, stirring music can enhance the creation of a tense atmosphere, making the audience feel more immersed; while in sad or sentimental scenes, gentle music can touch the audience's hearts and strengthen emotional resonance. This mutual reflection between music and narrative not only enriches the artistic expressiveness of the film, but also allows the audience to gain a deeper emotional experience during the viewing process. Therefore, the diversification trend of music composition for film and television is of great significance for improving the artistic quality and audience satisfaction of audiovisual works. The compatibility between musical styles and the themes of audiovisual works is not only about the conveyance of emotions, but also the resonance of cultures. For example, in some films with historical backgrounds or regional characteristics, the use of representative ethnic music or folk songs can not only create a unique cultural atmosphere, but also allow the audience to feel the charm and depth of the culture through the melodies. This combination of music and culture enables audiovisual works to convey not only emotions, but also cultural values and historical memories, thereby enriching the connotation and depth of the film. Therefore, the choice of musical styles plays a crucial role in audiovisual creation and is one of the key factors determining the success of a film. The music composition effectiveness evaluation of film and television is viewed as the MAGDM. Five potential film and television music $UY_i\left(i=1,2,3,4,5\right)$ are assessed with four attributes: ① UZ_1 is establishment of correct labor values; ② UZ_2 is cultivation of noble labor morality; ③ UZ_3 is Acquisition of comprehensive labor knowledge and skills; ④ UZ_4 is Cultivation of good working habits. Evidently, all attributes are beneficial attribute. NCN-TOPSIS procedure is illustrated for music composition effectiveness evaluation of film and television.

Step 1. Illustrate the NCN-matrix $QQ=\left(qq_{ij}\right)_{5\times4}$ (Table I).

Step 2. The NCN-matrix does not require normalization as all its attributes are advantageous.

Step 3. Illustrate the weights with CRITIC (Table II).

Step 4. Illustrate the NCNPIS and NCNNIS (see Table III).

Step 5. Illustrate the $NCNPISED\left(UY_i\right)$ and $NCNNISED\left(UY_i\right)$ (see Table IV):

Step 6. Illustrate the $NCNCC\left(UY_i\right)$ (see Table V).

Step 7. In light with $NCNCC\left(UY_i\right)$, the order is: $UY_5>UY_2>UY_4>UY_3>UY_1$ and UY_5 is the best one.

TABLE I. NCN-MATRIX

	ZZ_1	ZZ_2
YY_1	{([0.64, 0.62], [0.44, 0.42], [0.46, 0.56]), (0.44, 0.33, 0.36)}	{([0.54, 0.62], [0.44, 0.56], [0.44, 0.56]), (0.11, 0.19, 0.16)}
YY_2	{([0.82, 0.82], [0.24, 0.42], [0.65, 0.84]), (0.44, 0.33, 0.36)}	{([0.66, 0.68], [0.46, 0.42], [0.45, 0.64]), (0.31, 0.03, 0.42)}
YY_3	{([0.82, 0.82], [0.28, 0.42], [0.44, 0.56]), (0.26, 0.44, 0.34)}	{([0.82, 2.0], [0.24, 0.24], [0.54, 0.65]) , (0.16, 0.15, 0.11)}
YY_4	{([0.65, 0.62], [0.26, 0.28], [0.54, 0.65]), (0.44, 0.34, 0.32)}	{([0.62, 0.65], [0.45, 0.46], [0.44, 0.56]), (0.22, 0.35, 0.29)}
YY_5	{([0.62, 0.82], [0.42, 0.45], [0.46, 0.56]) , (0.44, 0.33, 0.36)}	{([0.86, 0.88], [0.56, 0.64], [0.56, 0.66]) , (0.44, 0.33, 0.36)}
	ZZ_3	ZZ_4
YY_1	{([0.62, 0.84], [0.45, 0.56], [0.44, 0.52]) , (0.14, 0.42, 0.43)}	{([0.64, 0.82], [0.46, 0.42], [0.64, 0.62]) , (0.31, 0.19, 0.16)}
YY_2	{([0.64, 0.62], [0.56, 0.64], [0.46, 0.54]) , (0.36, 0.04, 0.45)}	{([0.62, 0.84], [0.65, 0.64], [0.54, 0.66]) , (0.16, 0.15, 0.11)}

YY_3	{([0.62, 0.84], [0.46, 0.42], [0.55, 0.62]) , (0.31, 0.47, 0.26)}	{([0.82, 0.85], [0.26, 0.44], [0.62, 0.66]) , (0.43, 0.04, 0.46)}
YY_4	{([0.65, 0.82], [0.44, 0.58], [0.62, 0.64]) , (0.39, 0.13, 0.32)}	{([0.35, 0.38], [0.26, 0.25], [0.68, 0.88]) , (0.41, 0.05, 0.19)}
YY_5	{([0.24, 0.32], [0.66, 0.82], [0.24, 0.44]) , (0.24, 0.28, 0.36)}	{([0.64, 0.82], [0.45, 0.52], [0.45, 0.56]) , (0.49, 0.35, 0.41)}

TABLE II. THE WEIGHT INFORMATION

	UZ1	UZ2	UZ3	UZ4
weight	0.1684	0.3483	0.2927	0.1906

TABLE III. NCNPIS AND NCNNIS

	UZ1	UZ2
NCNPIS	{([0.82, 0.82], [0.28, 0.42], [0.44, 0.56]), (0.26, 0.44, 0.34)}	{([0.82, 2.0], [0.24, 0.24], [0.54, 0.65]) , (0.16, 0.15, 0.11)}
NCNNIS	{([0.62, 0.82], [0.42, 0.45], [0.46, 0.56]) , (0.44, 0.33, 0.36)}	{([0.54, 0.62], [0.44, 0.56], [0.44, 0.56]), (0.11, 0.19, 0.16)}
	UZ3	UZ4
NCNPIS	{([0.65, 0.82], [0.44, 0.58], [0.62, 0.64]) , (0.39, 0.13, 0.32)}	{([0.82, 0.85], [0.26, 0.44], [0.62, 0.66]) , (0.43, 0.04, 0.46)}
NCNNIS	{([0.24, 0.32], [0.66, 0.82], [0.24, 0.44]) , (0.24, 0.28, 0.36)}B.	{([0.35, 0.38], [0.26, 0.25], [0.68, 0.88]) , (0.41, 0.05, 0.19)}

TABLE IV. THE $NCNPISED(UY_i)$ AND $NCNNISED(UY_i)$

	$NCNPISED(UY_i)$	$NCNNISED(UY_i)$
UY1	0.4429	0.4275
UY2	0.5613	0.6937
UY3	0.7763	0.4105
UY4	0.5073	0.3102
UY5	0.5270	0.3919

TABLE V. THE $NCNCC(UY_i)$

	$NCNCC(UY_i)$	Order
UY_1	0.4280	5
UY_2	0.6163	2
UY_3	0.4460	4
UY_4	0.5238	3
UY_5	0.6971	1

B. Comparative Analysis

The NCN-TOPSIS approach is compared with NCNWAA approach and NCNWGA approach [46], NC-VIKOR approach [47], NCN-GRA approach[48]. Eventually, the final results are depicted in Table VI.

Derived from the results presented in Table VI, it is evident that the obtained best choice is UY_5, while the worst alternative is UY_1. In other words, the rankings produced by the different decision-making methods are slightly different. This observation suggests that the various approaches could effectively tackle the MADM from different perspectives. The NCN-TOPSIS approach, in particular, is a commonly used comprehensive evaluation approach that can make full use of the information contained in the original data. The results generated by the NCN-TOPSIS method can accurately reflect the relative performance gap between the evaluated alternatives. This is a key advantage of NCN-TOPSIS approach, as it provides DMs with a more nuanced and informative understanding of the alternatives under consideration. The slightly different rankings produced by the various methods highlight the importance of employing multiple decision-making techniques in complex, multi-criteria decision problems.

TABLE VI. ORDER FOR DIFFERENT APPROACHES

Approaches	Order
NCNWAA approach [46]	$UY_5 > UY_2 > UY_4 > UY_3 > UY_1$
NCNWGA approach [46]	$UY_5 > UY_2 > UY_4 > UY_3 > UY_1$
NC-VIKOR approach [47]	$UY_5 > UY_2 > UY_3 > UY_4 > UY_1$
NCN-GRA approach [48]	$UY_5 > UY_2 > UY_4 > UY_3 > UY_1$
The proposed NCN-TOPSIS approach	$UY_5 > UY_2 > UY_4 > UY_3 > UY_1$

V. CONCLUSION

The trend towards diversification in film and television music creation has had a profound impact on the artistic expressiveness of audiovisual works. With the integration and innovation of musical styles, film and television music is no longer limited to traditional background music or emotional scoring, but has become an important component of audiovisual works. The diversified musical styles provide richer means of emotional expression and atmosphere creation for audiovisual works, making the works more layered and deeper in terms of emotion, rhythm, and ambiance. This organic integration of music and visuals not only enhances the artistic appeal of the audiovisual works, but also improves the audience's viewing experience. The music composition effectiveness evaluation of film and television is MADM. In this work, the NCN-TOPSIS approach is devised for MADM, building upon the TOPSIS technique. The weight numbers of the attributes are determined using the CRITIC technique, ensuring an objective and systematic approach to assigning importance to the decision criteria. Furthermore, a novel NCN-TOPSIS method is developed for the context of MADM, and the detailed computational steps are provided. To demonstrate the efficacy of the proposed approach, an empirical example focused on the music composition effectiveness evaluation in the film and television industry is presented. This example showcases the superiority of the NCN-TOPSIS method in addressing complex, multi-criteria decision problems. The major contributions of this research are summarized: (1) The CRITIC method is utilized to objectively determine the weights of the attributes; (2) The NCN-TOPSIS method is developed within the framework of NCSs, extending the TOPSIS technique to this more generalized decision-making environment; (3) A numerical example on the music composition effectiveness evaluation in the film and television industry is provided, and comparative analyses are conducted to highlight the advantages of NCN-TOPSIS approach. By integrating the CRITIC method, developing the NCN-TOPSIS technique, and demonstrating its application in a real-world decision-making scenario, this research contributes to the advancement of MADM and MAGDM methodologies, offering DMs a robust and effective tool for addressing complex problems.

ACKNOWLEDGMENT

The work was supported by the Anhui Province Quality Course "Music Recording," Project Number: 2022jpkc026 and Anhui Province Quality Engineering Project "Integrated Practical Training Base at the Guangyi All-Media Center," Topic Number: 2021cjrh008.

REFERENCES

[1] M. Unehara and T. Onisawa, "Music composition system with human evaluation as human centered system," (in English), Soft Computing, Article vol. 7, no. 3, pp. 167-178, Jan 2003.

[2] M. Unehara and T. Onisawa, "Music composition by interaction between human and computer," (in English), New Generation Computing, Article vol. 23, no. 2, pp. 181-191, 2005.

[3] B. Eaglestone and P. D. Bamidis, "Music composition for the multi-disabled: A systems perspective," (in English), International Journal on Disability and Human Development, Review vol. 7, no. 1, pp. 19-24, Jan-Mar 2008.

[4] P. Sinha, "Artificial composition: An experiment on indian music," (in English), Journal of New Music Research, Article vol. 37, no. 3, pp. 221-232, 2008, Art. no. Pii 906893252.

[5] N. Collins, "Automatic composition of electroacoustic art music utilizing machine listening," (in English), Computer Music Journal, Article vol. 36, no. 3, pp. 8-23, Fal 2012.

[6] D. Williams et al., "Investigating perceived emotional correlates of rhythmic density in algorithmic music composition," (in English), Acm Transactions on Applied Perception, Article vol. 12, no. 3, p. 21, Jul 2015, Art. no. 8.

[7] M. Navarro, J. M. Corchado, and Y. Demazeau, "Music-mas: Modeling a harmonic composition system with virtual organizations to assist novice composers," (in English), Expert Systems with Applications, Article vol. 57, pp. 345-355, Sep 2016.

[8] C. De Felice, R. De Prisco, D. Malandrino, G. Zaccagnino, R. Zaccagnino, and R. Zizza, "Splicing music composition," (in English), Information Sciences, Article vol. 385, pp. 196-212, Apr 2017.

[9] D. Williams et al., "Affective calibration of musical feature sets in an emotionally intelligent music composition system," (in English), Acm Transactions on Applied Perception, Article vol. 14, no. 3, p. 13, Jul 2017, Art. no. 17.

[10] R. Abboud and J. Tekli, "Integration of nonparametric fuzzy classification with an evolutionary-developmental framework to perform music sentiment-based analysis and composition," (in English), Soft Computing, Article vol. 24, no. 13, pp. 9875-9925, Jul 2020.

[11] I. Abu Doush and A. Sawalha, "Automatic music composition using genetic algorithm and artificial neural networks," (in English), Malaysian Journal of Computer Science, Article vol. 33, no. 1, pp. 35-51, 2020.

[12] S. Shukla and H. Banka, "Markov-based genetic algorithm with e-greedy exploration for indian classical music composition," (in English), Expert Systems with Applications, Article vol. 211, p. 10, Jan 2023, Art. no. 118561.

[13] X. H. Gu, L. Q. Jiang, H. Chen, M. Li, and C. Liu, "Exploring brain dynamics via eeg and steady-state activation map networks in music composition," (in English), Brain Sciences, Article vol. 14, no. 3, p. 29, Mar 2024, Art. no. 216.

[14] X. W. Lei, "Analysing the effectiveness of online digital audio software and offline audio studios in fostering chinese folk music composition

skills in music education," (in English), Journal of Computer Assisted Learning, Article; Early Access p. 12, 2024 Jun 2024.

[15] R. De Prisco, G. Zaccagnino, and R. Zaccagnino, "Evocomposer: An evolutionary algorithm for 4-voice music compositions," (in English), Evolutionary Computation, Article vol. 28, no. 3, pp. 489-530, Sep 2020.

[16] N. N. Shi and Y. F. Wang, "Symmetry in computer-aided music composition system with social network analysis and artificial neural network methods," (in English), Journal of Ambient Intelligence and Humanized Computing, Article; Early Access p. 16, 2020 Aug 2020.

[17] S. L. Chen, Y. Zhong, and R. X. Du, "Automatic composition of guzheng (chinese zither) music using long short-term memory network (lstm) and reinforcement learning (rl)," (in English), Scientific Reports, Article vol. 12, no. 1, p. 17, Sep 2022, Art. no. 15829.

[18] M. X. Liu, "An eeg neurofeedback interactive model for emotional classification of electronic music compositions considering multi-brain synergistic brain-computer interfaces," (in English), Frontiers in Psychology, Article vol. 12, p. 11, Jan 2022, Art. no. 799132.

[19] S. Mukherjee and M. Mulimani, "Composeinstyle: Music composition with and without style transfer," (in English), Expert Systems with Applications, Article vol. 191, p. 21, Apr 2022, Art. no. 116195.

[20] H. Zhao, L. Narikbayeva, and Y. H. Wu, "Interactive systems for music composition: A new paradigm in music education," (in English), Interactive Learning Environments, Article; Early Access p. 10, 2022 Aug 2022.

[21] P. Ferreira, R. Limongi, and L. P. Fávero, "Generating music with data: Application of deep learning models for symbolic music composition," (in English), Applied Sciences-Basel, Article vol. 13, no. 7, p. 19, Apr 2023, Art. no. 4543.

[22] W. M. Liu, "Literature survey of multi-track music generation model based on generative confrontation network in intelligent composition," (in English), Journal of Supercomputing, Article vol. 79, no. 6, pp. 6560-6582, Apr 2023.

[23] T. Mahmood, Z. Ali, H. Garg, L. Zedam, and R. Chinram, "Correlation coefficient and entropy measures based on complex dual type-2 hesitant fuzzy sets and their applications," (in English), Journal of Mathematics, Article vol. 2021, p. 34, Mar 2021, Art. no. 2568391.

[24] K. Ullah, H. Garg, Z. Gul, T. Mahmood, Q. Khan, and Z. Ali, "Interval valued t-spherical fuzzy information aggregation based on dombi t-norm and dombi t-conorm for multi-attribute decision making problems," (in English), Symmetry-Basel, Article vol. 13, no. 6, p. 26, Jun 2021, Art. no. 1053.

[25] R. M. Zulqarnain et al., "Algorithms for a generalized multipolar neutrosophic soft set with information measures to solve medical diagnoses and decision-making problems," (in English), Journal of Mathematics, Article vol. 2021, p. 30, May 2021, Art. no. 6654657.

[26] H. Garg and D. Rani, "An efficient intuitionistic fuzzy multimoora approach based on novel aggregation operators for the assessment of solid waste management techniques," (in English), Applied Intelligence, Article vol. 52, no. 4, pp. 4330-4363, Mar 2022.

[27] H. Garg, J. Vimala, S. Rajareega, D. Preethi, and L. Perez-Dominguez, "Complex intuitionistic fuzzy soft swara - copras approach: An application of erp software selection," (in English), Aims Mathematics, Article vol. 7, no. 4, pp. 5895-5909, 2022.

[28] R. Verma and E. Alvarez-Miranda, "Multiple-attribute group decision-making approach using power aggregation operators with critic-waspas method under 2-dimensional linguistic intuitionistic fuzzy framework," (in English), Applied Soft Computing, Article vol. 157, p. 33, May 2024, Art. no. 111466.

[29] M. Jamil, F. Afzal, A. Maqbool, S. Abdullah, A. Akgül, and A. Bariq, "Multiple attribute group decision making approach for selection of robot under induced bipolar neutrosophic aggregation operators," (in English), Complex & Intelligent Systems, Article vol. 10, no. 2, pp. 2765-2779, Apr 2024.

[30] H. Sun, Z. Yang, Q. Cai, G. W. Wei, and Z. W. Mo, "An extended exp-todim method for multiple attribute decision making based on the z-wasserstein distance," (in English), Expert Systems with Applications, Article vol. 214, p. 14, Mar 2023, Art. no. 119114.

[31] T. Senapati, G. Y. Chen, R. Mesiar, and R. R. Yager, "Intuitionistic fuzzy geometric aggregation operators in the framework of aczel-alsina triangular norms and their application to multiple attribute decision making," (in English), Expert Systems with Applications, Article vol. 212, p. 15, Feb 2023, Art. no. 118832.

[32] F. Riazi, M. H. Dehbozorgi, M. R. Feylizadeh, and M. Riazi, "Enhanced oil recovery prioritization based on feasibility criteria using intuitionistic fuzzy multiple attribute decision making: A case study in an oil reservoir," (in English), Petroleum Science and Technology, Article; Early Access p. 19, 2023 Jun 2023.

[33] M. Palanikumar, K. Arulmozhi, C. Jana, and M. Pal, "Multiple-attribute decision-making spherical vague normal operators and their applications for the selection of farmers," (in English), Expert Systems, Article vol. 40, no. 3, p. 26, Mar 2023.

[34] A. Noori, H. Bonakdari, A. H. Salimi, L. Pourkarimi, and J. M. Samakosh, "A novel multiple attribute decision-making approach for assessing the effectiveness of advertising to a target audience on drinking water consumers? Behavior considering age and education level," (in English), Habitat International, Article vol. 133, p. 9, Mar 2023, Art. no. 102749.

[35] B. Q. Ning, R. Lin, G. W. Wei, and X. D. Chen, "Edas method for multiple attribute group decision making with probabilistic dual hesitant fuzzy information and its application to suppliers selection," (in English), Technological and Economic Development of Economy, Article vol. 29, no. 2, pp. 326-352, 2023.

[36] T. Mahmood, U. U. Rehman, and Z. Ali, "Analysis and applications of aczel-alsina aggregation operators based on bipolar complex fuzzy information in multiple attribute decision making," (in English), Information Sciences, Article vol. 619, pp. 817-833, Jan 2023.

[37] A. Jaglan, G. Sadera, P. Singh, B. P. Singh, and G. Goel, "Probiotic potential of gluten degrading bacillus tequilensis ajg23 isolated from indian traditional cereal-fermented foods as determined by multiple attribute decision-making analysis," (in English), Food Research International, Article vol. 174, p. 10, Dec 2023, Art. no. 113516.

[38] Y.-J. Lai, T.-Y. Liu, and C.-L. Hwang, "Topsis for modm," European journal of operational research, vol. 76, no. 3, pp. 486-500, 1994.

[39] C. T. Chen, "Extensions of the topsis for group decision-making under fuzzy environment," (in English), Fuzzy Sets and Systems, Article vol. 114, no. 1, pp. 1-9, Aug 2000.

[40] M. Ali, I. Deli, and F. Smarandache, "The theory of neutrosophic cubic sets and their applications in pattern recognition," (in English), Journal of Intelligent & Fuzzy Systems, Article vol. 30, no. 4, pp. 1957-1963, 2016.

[41] H. Wang, F. Smarandache, Y. Q. Zhang, and R. Sunderraman, "Single valued neutrosophic sets," Multispace Multistruct, no. 4, pp. 410-413, 2010.

[42] H. Wang, F. Smarandache, Y. Q. Zhang, and R. Sunderraman, "Interval neutrosophic sets and logic: Theory and applications in computing," Hexis: Phoenix, AZ, USA, 2005.

[43] D. Ajay, J. Aldring, and S. Nivetha, "Neutrosophic cubic fuzzy dombi hamy mean operators with application to multi-criteria decision making," Neutrosophic Sets and Systems, vol. 38, pp. 293-316, 2020.

[44] S. Pramanik, P. P. Dey, B. C. Giri, and F. Smarandache, "An extended topsis for multi-attribute decision making problems with neutrosophic cubic information," Neutrosophic Sets and Systems, vol. 17, pp. 20-28, 2017.

[45] D. Diakoulaki, G. Mavrotas, and L. Papayannakis, "Determining objective weights in multiple criteria problems: The critic method," Computers & Operations Research, vol. 22, no. 7, pp. 763-770, 1995.

[46] J. Ye, "Operations and aggregation method of neutrosophic cubic numbers for multiple attribute decision-making," (in English), Soft Computing, Article; Proceedings Paper vol. 22, no. 22, pp. 7435-7444, Nov 2018.

[47] S. Pramanik, S. Dalapati, S. Alam, and T. K. Roy, "Nc-vikor based magdm strategy under neutrosophic cubic set environment," Neutrosophic Sets and Systems, vol. 20, pp. 95-108, 2018.

[48] P. Liu, "Enhanced grey relational analysis method for neutrosophic cubic number madm and applications to decorative wall hanging design effect evaluation," Journal of Intelligent & Fuzzy Systems, vol. 45, no. 5, pp. 7507-7518, 2023.