Fuzzy Matter-element Analysis Model of IP-influence Based on EFA-Euclid Approach Degree

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Abstract. With the rise of Intellectual Property (IP) films, IP influence has become one of the important criteria to consider whether an IP film has development value[1]. The influence of the IP films is a fuzzy concept, and its evaluation is not only affected by a variety of factors (both qualitative and quantitative indicators), but also has the problem of incompatible single indicator evaluation. Based on the actual situation of China's IP film market and the characteristics of literary works IP, this paper constructs an evaluation index system of the influence of IP films. On the basis of fuzzy matter-element analysis theory, the exploratory factor analysis is introduced into the weight calculation, and combined with the Euclid approach degree, the fuzzy matter-element model based on EFA-Euclid Approach Degree is established, which sorts the IP influence according to the size of the relative paste progress, and the evaluation result is more objective and reasonable. This model ranks IP influence according to the relative approach degree, and the evaluation results are more objective and reasonable.

1. Introduction

In the Internet era, "IP" in the field culture has various forms of presentation, such as games, films, buzzwords, TV dramas, etc. In China, this concept refers to those creative intellectual property rights with high concentration, great influence and can be reproduced and recreated[2]. With the influx of commercial capital and the rapid rise of popular culture, the film industry is developing rapidly, and the film production mode and industrial pattern have changed a lot, while the IP film is also gradually rising. From the perspective of "5W" communication, IP films have some influence on "famous directors and editors", multi-element plots and selling points, diverse screening channels, a large fan base and good communication effects[3]. Therefore, major film and television companies have launched many large-scale projects around IP, trying to attract the potential customers in order to create greater profits[4]. Therefore, the first question for investors is how to scientifically consider whether the content of "original IP" is of high-quality and has room for sustainable development, so as to make reasonable use of IP resources, reduce investment risks and obtain greater returns.

At present, almost all studies on the impact of IP film have obtained quantitative results through analysis, and then ranked the magnitude of influence. In fact, it is difficult to measure the index of IP influence with a certain value, or it can be said to be vague. Therefore, this paper introduces the fuzzy matter-element method[5], which combines the matter-element analysis principle with fuzzy set theory, which is suitable for solving the problem of fuzziness in the process of multi index evaluation, and the incompatibility with the result of single index. The model combines exploratory factor analysis(EFA) and Euclid approach degree[6], which is more accurate and effective in the extraction for multi-
indicator common information extraction, and has important theoretical significance and practical value.

2. IP Influence Evaluation Index Selection

The influence of IP is affected by a variety of indicators. Although IP itself is difficult to measure, the relevant situation of its platform, communication channels, and audiences can be quantified, these quantifiable indicators reflect the IP influence in different aspects[7]. Therefore, the evaluation of IP influence can be decomposed into related evaluations of various quantifiable indicators, and a new quantifiable evaluation system can be constructed to reflect the influence of IP.

The indicators selected in this paper are as follows: The first-level indicators are IP performance, IP network popularity, IP content, IP communicator performance, and IP potential derivative value. Specific IP impact evaluation indicators are shown in Table 1.

| First-level Indicators                  | Second-level Indicators                                      |
|----------------------------------------|--------------------------------------------------------------|
| IP Performance                         | Audience attention;                                          |
|                                        | Awards;                                                      |
|                                        | IP data;                                                     |
|                                        | IP public praise;                                             |
|                                        | Social website;                                              |
|                                        | Information website;                                         |
| IP Network Popularity                  | Ticketing website;                                           |
|                                        | Other websites;                                              |
|                                        | Search number;                                               |
|                                        | News volume;                                                 |
|                                        | IP theme;                                                    |
| IP Content                             | Emotional inclination;                                       |
|                                        | Content risk;                                                |
| IP Communicator Performance            | Strength of communicators;                                   |
| IP Potential Derivative Value          | Network popularity of communicators;                         |
|                                        | Derivatization;                                              |

3. Fuzzy Matter-element Analysis based on EFA-Euclid Approach Degree

The influence of IP itself is a vague concept. Based on the fuzzy matter-element analysis theory, this paper introduces exploratory factor analysis into the calculation of weights, and establishes a model based on Euclid Approach Degree. The specific flowchart is as follows:
3.1. The Complex Fuzzy Matter-element

Matter-element is the basic element to describe things, we use ordered triple \( R = (P, C, x) \) to express them, where \( P \) is the name of the thing, \( C \) is the characteristic value of \( P \), \( x \) is the corresponding value of \( C \). If \( x \) is fuzzy, the \( R \) is called the fuzzy matter-element, and it is written as:

\[
R = \begin{bmatrix} P \\ C \\ x \end{bmatrix}
\]  

(1)

Complex fuzzy matter-elements are denoted as:

\[
R = \begin{bmatrix} P_i \\ C_j \\ x_{ij} \end{bmatrix}
\]  

(2)

Where, \( P_i \) represents the \( i \)-th evaluation sample, \( C_j \) represents the \( j \)-th evaluation index, and \( x_{ij} \) represents the fuzzy value (\( i = 1, 2, \ldots, n; j = 1, 2, \ldots, m \)) corresponding to the \( j \)-th index of the \( i \)-th sample.

3.2. Transforming Complex Fuzzy Matter-element Matrix into Membership Matrix

Preferential membership degree, that is, the degree of subordination of the corresponding fuzzy value of each evaluation index to the standard sample[8]. Because the influence of each index value on the evaluation results is very different, some are larger and better, some are smaller and better, some are closer to a certain constant and better. The evaluation indexes in this paper are all the larger and better. The calculation formula of preferential membership degree is:

\[
v_{ij} = \frac{x_{ij} - \min x_{ij}}{\max x_{ij} - \min x_{ij}}
\]  

(3)

Based on the calculation results, the fuzzy matter-element of preferential membership is constructed and recorded as:
3.3. Construction Standard Fuzzy Matter-element and Differential Square Composite Fuzzy Matter-element

In general, the standard fuzzy matter-element is the optimal fuzzy matter-element, which is recorded as:

$$\hat{R} = \begin{bmatrix}
    P_1 & \cdots & P_n \\
    C_1 & \cdots & C_n \\
    v_{11} & \cdots & v_{1m} \\
    \vdots & \ddots & \vdots \\
    v_{n1} & \cdots & v_{nm}
\end{bmatrix}$$

(4)

Among them, $v_{ij}$ is the maximum or minimum value of superiority membership of the $j$-th evaluation index in $R$. Let $\delta_j = [v_{ij} - v_{ij}]^T$ $(i=1,2,\cdots,n; j=1,2,\cdots,m)$, then the differential square compound fuzzy matter-element can be expressed as:

$$R_\delta = \begin{bmatrix}
    P_0 \\
    C_1 \\
    \delta_1 \\
    \vdots \\
    \delta_m \\
    C_n \\
    \delta_m
\end{bmatrix}$$

(5)

3.4. EFA Empowerment

Exploratory Factor Analysis (EFA) is a form of factor analysis, which aims to discover a small set of factors hidden in the data that affect the observed variables. According to the degree of correlation between each factor and each observed variable, explaining the internal structure of a set of observable variables. EFA has no prior information and is suitable for tentative analysis of data without theoretical support.

The form of the model is:

$$X_i = a_1F_1 + a_2F_2 + \cdots + a_pF_p + e_i$$

(7)

Among them, $X_i$ $(i=1,2,\cdots,n)$ is the $i$-th observable variable, $F_j$ $(j=1,2,\cdots,p)$ is a common factor, and $p < n$ : $a_i$ can be considered as the contribution value of each factor to the composite observable variable; $e_i$ is the unique part of the variable that cannot be explained by the common factor $X_i$, which is generally ignored in the calculation. The weight calculation steps of exploratory factor analysis are as follows:

1. The calculation formula of factor load matrix is as:

$$B = \begin{bmatrix}
    \beta_1 \\
    \beta_2 \\
    \vdots \\
    \beta_p \\
\end{bmatrix}$$

(8)

Among them, $\beta_j$ is the percentage of variance after rotation of common factor $F_j$, and $\gamma$ is the cumulative percentage of variance after rotation of all common factors.

2. The factor score matrix $M$ is obtained by factor rotation, which is recorded as:

$$M = \begin{bmatrix}
    a_{11} & a_{12} & \cdots & a_{1p} \\
    a_{21} & a_{22} & \cdots & a_{2p} \\
    \vdots & \vdots & \ddots & \vdots \\
    a_{n1} & a_{n2} & \cdots & a_{np}
\end{bmatrix}$$

(9)

3. Record $W = (\lambda_1, \lambda_2, \cdots, \lambda_m)^T$ as the weight coefficient matrix, where $\lambda_j$ is the weight coefficient of the $j$-th index, and the calculation formula is:

$$W = MB$$

(10)

Normalize the weight coefficient of each index, and the calculation formula is:
3.5. Euclid Approach Degree Calculation

The Euclid approach degree indicates the approach degree between each sample and the optimal sample [9], the closer the two are, the larger the corresponding value is, otherwise the smaller the corresponding value is. Therefore, the larger the Euclid approach degree is, the better the sample is, so as to rank the evaluation samples. Combined with fuzzy operator algorithm \( M(\cdot, \cdot) \), the calculation formula of Euclid approach degree is:

\[
\rho_i = 1 - \sqrt{\sum_{j=1}^{m} \omega_j \delta_{ij}} (i = 1, 2, \ldots, m)
\]

(12)

According to the Euclid approach degree, the complex fuzzy matter-element is:

\[
\mathbf{R}_p = \begin{bmatrix} \rho_1 & P_1 & \cdots & P_n \end{bmatrix}
\]

(13)

4. Experiments

4.1. Dataset Introduction

The concept of IP film has been rising in China since 2013 [10]. This paper collects films released in Mainland China in 2016-2019 with a box office of more than 10 million. Due to the large amount of data and the large variety of IP, we select IP films adapted from literary works as the analysis object, which contains a total of 42 films. In order to make the data more comprehensive and accurate, this paper adopts a reasonable and effective method to complete the collection and cleaning of relevant data (The problem of missing data in individual samples was solved by linear interpolation using SPSS). In addition, the data of some niche films is difficult to obtain or has been lost. In order to reduce the impact of the poor film data on the analysis results, some low box office niche films are eliminated.

4.2. IP-influence Evaluation of Literary Works

According to the literature works IP influence evaluation index system and formula (2), the complex fuzzy matter-element is constructed as:

\[
\mathbf{R} = \begin{bmatrix} C_1 & C_2 & C_3 & 0.86 & 1.23 & 4.02 & 2.75 & \Lambda & 0.08 \\ C_2 & 3709.4 & 9103.2 & 14092.2 & 18836.6 & \Lambda & 220.3 \\ C_3 & 5000000 & 2500000 & 2200000 & 1227.7 & \Lambda & 3028 \\ C_4 & 3950973 & 547457 & 469681 & 645631 & \Lambda & 22143 \\ M & M & M & M & M & M & M & M & \end{bmatrix}
\]

The literary works' IP influence evaluation indexes are larger and better, according to the formula (3), the preferential fuzzy matter-element is obtained as:

\[
\mathbf{\hat{R}} = \begin{bmatrix} C_1 & C_2 & C_3 & 0.113 & 0.162 & 0.532 & 0.363 & \Lambda & 0.009 \\ C_2 & 0.053 & 0.132 & 0.205 & 0.275 & \Lambda & 0.002 \\ C_3 & 0.590 & 0.271 & 0.259 & 0.001 & \Lambda & 0.003 \\ C_4 & 0.841 & 0.115 & \Lambda & 0.136 & \Lambda & 0.011 \\ M & M & M & M & M & M & M & M & \end{bmatrix}
\]

According to the index characteristics and the calculation of preferential membership degree, selecting the maximum value of each evaluation index, and the standard fuzzy matter-element is obtained as:
According to the standard fuzzy matter-element and formula (6), the difference square compound fuzzy matter-element is obtained as:

\[
\mathbf{R} = \begin{bmatrix}
P_1 \\
P_2 \\
P_3 \\
P_4 \\
C_1 \\
C_2 \\
C_3 \\
C_4 \\
M \\
M \\
M \\
M \\
\end{bmatrix}
\]

The KMO statistics is to determine the correlation between variables by comparing the magnitude of the simple correlation coefficient and partial correlation coefficient. Bartlett's spherical test is used to test the distribution of data and the independence of variables.

| IP type     | KMO | Bartlett's Test of Sphericity |
|-------------|-----|-------------------------------|
|             |     | Approx. Chi-square df Sig.    |
| literary works | 0.629 | 848.829 | 231 | 0.000 |

It can be seen from Table 2 that the kmo value of literary works IP is 0.629, the P-value of Bartlett test is less than 0.05, and the rejection of correlation coefficient matrix is a zero hypothesis of a unit matrix, that is the correlation coefficient is significantly different from the identity matrix, so the data of literary works IP is suitable for EFA analysis.

Using SPSS to perform EFA analysis on the data of literary works IP, seven common factors are extracted based on the principle that the eigenvalue is larger than 1, and the cumulative contribution rate is 82.52%. According to the formula (12), the complex fuzzy matter-element of Euclid approach degree is obtained. The specific values and ranking are shown in Table 3.

| Sample | Matter-element Analysis Result | Sequence | Sample | Matter-element Analysis Result | Sequence |
|--------|--------------------------------|----------|--------|--------------------------------|----------|
| 1      | 0.35                           | 2        | 22     | 0.084                          | 33       |
| 2      | 0.193                          | 8        | 23     | 0.076                          | 35       |
| 3      | 0.337                          | 3        | 24     | 0.103                          | 24       |
| 4      | 0.221                          | 6        | 25     | 0.264                          | 5        |
| 5      | 0.147                          | 15       | 26     | 0.152                          | 13       |
| 6      | 0.105                          | 23       | 27     | 0.09                           | 29       |
| 7      | 0.117                          | 18       | 28     | 0.12                           | 16       |
| 8      | 0.092                          | 27       | 29     | 0.084                          | 34       |
| 9      | 0.091                          | 28       | 30     | 0.109                          | 21       |
| 10     | 0.119                          | 17       | 31     | 0.214                          | 7        |
| 11     | 0.098                          | 26       | 32     | 0.066                          | 38       |
| 12     | 0.299                          | 4        | 33     | 0.048                          | 40       |
| 13     | 0.179                          | 10       | 34     | 0.149                          | 14       |
According to the IP influence ranking of various literary works, investors could choose the most influential literary works for film adaptation to ensure that the subsequent development of derivatives has lower risk and higher return.

5. Conclusion
Based on the actual situation and characteristics of Chinese IP film market, and on the basis of fuzzy matter-element analysis theory, this paper introduce the exploratory factor analysis method into the weight calculation, and combined with the Euclid approach degree, the fuzzy matter-element model based on EFA-Euclid Approach Degree is established.

The model is applied to the comprehensive evaluation of literary IP through experiments, and the ranking of IP influence is obtained, which proves the effectiveness of the model. Accurate and reasonable analysis can be conducted from multiple perspectives, so that investors can understand in detail whether the content of "original IP" is of high quality, whether it has the value of deep mining and whether it has room for sustainable development, and then can make more rational use of IP resources, reduce investment risk and gain more profits.

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