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An empirical study on the financial performance of animation industry based on entropy value method and K-means clustering method

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Abstract: *Under the strong support of various national policies, the animation industry has developed rapidly. In order to enable the emerging animation industry to maintain a high-speed growth for a long time, we should pay more attention to the analysis of the relevant financial performance of such enterprises. This paper focuses on the animation industry, and establishes an indicator system from the five dimensions of profitability, solvency, operational ability, development ability, and non-financial indicators. The entropy method is used to objectively estimate the weight of the index to obtain the final score of the enterprise. Then, the K-means clustering method is further combined to classify the score of enterprise according to categories, and the quantitative performance analysis of the animation industry is carried out, which provides a reference for subsequent financial performance analysis. Finally, some suggestions are put forward for the development of the animation industry from the three aspects: enterprise management, cultural and technological innovation, and government support policies.*

Keywords: *Animation industry; financial performance analysis; entropy method; K-means clustering method*

1. Introduction

With the rapid development of the domestic Internet economy, the innovation and entrepreneurship economy represented by animation has become an important engine for developing cultural industries. The strong support of national development policies has made related fields more critical. The number of enterprises has entered a period of rapid growth. The "14th Five-Year Plan" cultural industry development plan clearly states that by 2025, China will achieve the goal of "a more sound cultural industry system and market system, a continuous optimization of the layout of the cultural industry structure, and a further increase in the proportion of added value of cultural and related industries in GDP". It can be seen that to respond to the state's call and promote the rapid development of animation enterprises, it is crucial to improve their internal performance evaluation. Hu Xiangmin [1] Evaluates the financial performance of the hydropower industry based on the entropy method in combination with China's national conditions and policies. It is concluded that the power industry should strengthen its comprehensive capabilities, and this study is more practical and practical. Hou Xiangding [2] used the factor analysis method to study the financial performance of the logistics supply chain industry, and concluded that there was no disparity between the leading enterprises in the industry. The conclusion that large enterprises have seized more market share is highly targeted and comprehensive, which provides essential reference significance for the subsequent literature research. Jingjing Geng and Li Liu [3] used factor analysis and DEA methods to conduct core enterprises in the business ecosystem Financial performance evaluation. It is concluded that such enterprises should fully explore their existing financial resources to improve their financial value and output levels. However, this study only considers the financial indicators of enterprises, and does not consider non-financial indicators. There are limitations in influencing factors such as the economic environment and government decision-making.

The animation industry is not only one of the important components of China's cultural industry, but also an emerging sunrise industry in the country. Therefore, studying the financial performance evaluation of this industry can internally provide corporate governance for animation enterprises and the direction of performance appraisal, to the external response to the "innovation-driven" national strategy, to promote the development of the animation industry. Compared with the relevant research literature at home and abroad, this paper mainly has the following contributions and innovations: First, this paper mainly uses the entropy value method and the K-means clustering method to analyze it. The entropy

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value method determines the weight according to the degree of variation of the index value, which is objective and accurate; The K-means clustering method classifies the index by dimensionality reduction, and the operation principle is simple and clear. Second, the indicator system established in this paper includes financial and non-financial [4] indicators, which can fully reflect the effect and operational ability of asset utilization management in the animation industry. Third, the research related to financial performance mainly focuses on the logistics supply chain industry, manufacturing industry, banking and finance industry, etc. Related to the animation industry, studies are ill-documented and have few empirical studies. Therefore, this paper combines the existing theoretical and literature research results, and uses the entropy method and the K-means clustering combination method to evaluate the financial performance of the animation industry, objectively and fairly measure the impact of different indicators on corporate performance.

2. Establishment of enterprise financial performance analysis index system

2.1. Establishment of the indicator system

Combining existing literature[4,5,6,7]and the animation industry particularity, this paper establishes an evaluation index system in six parts: profitability, solvency, operation capacity, development capacity, shareholder profit and non-financial indicators. Profitability is a reflection of a business from a profit perspective profit state, and the main measure is the net profit margin on total assets(X_1), operating profit margin (X_2), the net profit margin on sales (X_3), return on assets (X_4), cost-expense profit margin (X_5). Solvency reflects important factors in the financial position and results of operations of the enterprise, and the main metrics are the Gearing ratio(X_6), Cash flow ratio(X_7), Stake multiplier(X_8), Quick ratio (X_9). Operational capability reflects capital turnover and the realization of value creation through liquid assets. The main measurement indicators are the total asset turnover ratio (X_{10}), current asset turnover (X_{11}), and accounts receivable turnover (X_{12}). Development capacity refers to the enterprise's potential ability to maintain further expansion in the process of operation. The main indicators are shareholders' equity growth rate (X_{13}), total asset growth rate (X_{14}), operating profit growth rate (X_{15}), operating income growth rate (X_{16}), net assets per share (X_{17}), yield per share (X_{18}). Non-financial indicators are management performance and the company well-developed indicator, wich help to reveal core competencies and areas for improvement. The main measurement indicators are innovation capability (X 19) and employee turnover rate (X 20). The index of innovation capability is expressed by the ratio of R&D expenditure to total operating cost.

2.2. Source of data

The data in this paper is mainly derived from the annual reports of listed companies in the Oriental Wealth Choice financial terminal and the Guotai'an database. Through the data screening, 15 listed cultural enterprises were randomly selected. Due to the incomplete financial data of other years, based on the above indicator system, only the financial indicator data of the above-mentioned enterprises in 2020 is empirically analyzed.

3. Based on the entropy method and K-means clustering algorithm, the financial performance analysis of the animation industry is carried out

3.1. Research ideas

This paper aims to analyze the financial performance of some enterprises in the animation industry by analyzing the final score of the indicator system, so as to draw conclusions and put forward policy recommendations that are in line with the actual development of the industry. In the research process, it is necessary to determine the weight of each indicator, according to which the importance of each financial indicator to the performance of the enterprise is judged, and the entropy value method is used as the data weight processing method. Finally, the K-means clustering algorithm is used to classify each enterprise's scores and analyze the animation industry's financial performance.

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3.2. Conduct financial performance analysis of the animation industry based on the entropy method

3.2.1 Basic steps of the entropy method

In this paper, the entropy method is used to calculate the weights of the indicator. The entropy method determines the objective weight according to the degree of variation of the index. The smaller the entropy of the information contained in the indicator, the more information it will provide, the greater the possibility of its mutation, and the greater the final proportion.

(1) In order to ensure the comparability of data, it is necessary to homogenize all indicators. Due to the different dimensions of each indicator, after the above operation, the indicators are standardized as follows:

$$X'_{ij} = \frac{X_{ij} - minX_j}{maxX_j - minX_j} \tag{1}$$

(2) In order to represent the proportion of each indicator in the enterprise, to show the degree of variation of it, that isP_{ij}, to understand the proportion of the j the indicator in the i enterprise:

$$P_{ij} = \frac{X'_{ij}}{\sum_{i=1}^{n} X'_{ij}}, i = 1, \dots, n, j = 1, \dots, m \tag{2}$$

(3) The amount of information is the amount of information that needs to be grasped to understand an unknown thing, and the probability of the occurrence of unknown things is negatively correlated. The information entropy is the average value of the amount of information that reflects the degree of dispersion and difference of the indicator, and the calculation formula is as follows:

$$e_j = -(\ln n)^{-1} \times \sum_{i=1}^{n} p_{ij} \ln p_{ij} \tag{3}$$

To ensure that equation (3) makes sense, replace it with 0.0001 when p=0.

(4) The index's entropy value, the amount of information provided, and the weight play an inverse role in the comprehensive evaluation. In order to facilitate the later analysis and comparison, and carry out homogenization processing, we use information redundancy $g_j$to represent:

$$g_j = 1 - e_j \tag{4}$$

(5) Since the probability of the occurrence of financial indicators of animation enterprises is inversely proportional to the amount of information and information entropy, and the degree of information redundancy is inversely proportional to the information entropy, the probability of financial indicators is proportional to the degree of information redundancy. The expression formula is as follows:

$$w_j = \frac{g_j}{\sum_{i=1}^{n} g_j} \tag{5}$$

3.3. Analysis of results

3.3.1 Weight angle analysis

According to the above research ideas, the python programming is used to process the data of 15 animation companies randomly selected, calculate the total weight of each index and dimension, and then analyze the advantages and disadvantages of each enterprise. The results are shown in Table 1:

It can be seen from Table 1 that accounts receivable turnover (X_{12}) and innovation capability (X_{19}) have relatively large weights. Accounts receivable turnover ratio is a net income from credit sales in a certain period divided by the average balance of accounts receivable, an indicator of the management efficiency of the enterprise, reflecting the funds recycling and exploit horizontal. Animation industry is a multi-production chain operation, including animation creation, production, broadcasting, and the development of related derivatives, so there is much demand for working capital. Anime products belong to the entertainment culture category, and there is a wide range and malleability in the audience. The operating income it earns is durable over time. In 2018 the annual operating income exceeded 10 billion, so the accounts receivable turnover rate is moving the comic industry, the weight is larger. The ability to innovate is the ratio of R&D expenditure to operating costs, which measures the competitiveness and innovation ability of enterprises in the market, reflecting the ability to optimize the integration of resources and collaborate on multi-factor innovation to achieve product value-added. Animation is a virtual image created by some electronic media software, which displays the story through colorful pictures. In order to attract more groups and occupy the domestic and foreign markets, increasing

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spending on product research is essential.

The weights of total asset net interest rate and return on assets are smaller, both of which are indicators of the long-term profitability of enterprises and the weight difference is small. In addition, the solvency dimension, and the asset-liability ratio in the medium also fluctuates at this level. The utilization rate of the working capital of the animation industry is high, the capital turnover is flexible, and the level of industrial debt is not high; The animation industry belongs to the cultural category, and its profit level is relatively balanced every year, so the above indicators have a small weight. Its role in improving the financial performance level of enterprises is not apparent.

Table 1: Weight table of the index system of 15 animation enterprises

Level 1 indicators	weight	Secondary indicators	weight
Profit indicator	0.1084	Net interest rate on total assets	0.0181
		Operating margin	0.0264
		Net profit margin on sales	0.0250
		Return on assets	0.0182
		Cost expense profit margin	0.0206
Solvency	0.2904	Gearing ratio	0.0187
		Cash flow ratio	0.2141
		Stake multiplier	0.0289
		Quick ratio	0.0286
Operational capabilities	0.2077	Total asset turnover	0.0604
		Current asset turnover	0.0616
		Accounts receivable turnover	0.0857
Develop capacity	0.2713	Shareholder equity growth rate	0.0345
		Growth rate of total assets	0.0787
		Growth rate of operating profit	0.0201
		Revenue growth rate	0.0780
		Net assets per share	0.0359
		Yield per share	0.0241
Non-financial indicators	0.1221	The ability to innovate	0.0840
		Employee turnover	0.0381

3.3.2 Scoring angle analysis

The normalized data of each indicator is multiplied by each indicator, and the index scores of the same dimension are added to obtain the scores of each sample enterprise in 2020 in five dimensions, and then the total score of each sample enterprise in 2020 can be obtained. The score results and rankings are shown in Table 2.

Table 2: Summary table of scores of 15 animation companies

enterprise	Profitability	Solvency	Operational capabilities	Develop capacity	Non-financial indicators	Total score
Dragon Culture	0.0993	0.2449	0.0807	0.1797	0.0890	0.6935
Ofi Entertainment	0.0942	0.0820	0.1977	0.1381	0.1123	0.6243
Jebsen Shares	0.0913	0.1286	0.0837	0.1371	0.0457	0.4864
Zhongguang Natural Selection	0.0962	0.0471	0.1177	0.1651	0.0603	0.4863
Look east to the era	0.0940	0.0396	0.0277	0.2034	0.1099	0.4746
Mason Culture	0.0814	0.1031	0.1146	0.1086	0.0557	0.4634
Huayi Brothers	0.0884	0.0921	0.0952	0.1248	0.0189	0.4194
Wanda Movies	0.0815	0.0869	0.1047	0.1087	0.0142	0.3959
Chinese films	0.0947	0.0707	0.0407	0.1401	0.0370	0.3831
Light Media	0.1022	0.0525	0.0468	0.1274	0.0530	0.3819
Eastern Network	0.0102	0.0456	0.1581	0.0856	0.0627	0.3621
Ciwen Media	0.0895	0.0794	0.0426	0.1266	0.0219	0.3600
Zhewen Pictures	0.0870	0.0468	0.0870	0.0943	0.0152	0.3304
Central Andnan culture	0.1071	0.0641	0.0357	0.0777	0.0301	0.3147
Cultural Investment Holdings	0.0357	0.0916	0.0048	0.0550	0.0447	0.2318

From the total scores of the 15 enterprises in the above table, it can be seen that the leading companies are Aofei Entertainment and Dinglong Cultural Enterprises, occupying most of the market share, and the overall gap between other enterprises is not large, and they are in a balanced development status. The first score is Dinglong Culture, whose business categories are rich and diverse, mainly including titanium ore, film and television, games, etc., and is committed to high-quality IP. The operation of the whole industry chain. In addition, the company has rich and high-quality IP reserves and creative ability,

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excellent channels for realizing cash such as movies, online games, peripheral derivatives, etc., and its solvency is obviously higher than that of other companies. Strong debt security is conducive to the long-term healthy development of enterprises. Aofei Entertainment scored second only to Dinglong Culture, and it is China's first listed animation enterprise. Its core profit point is animation creation, using "animation" + "toys" business model to ensure business revenue. Create a pan-entertainment model to expand the scale of the industrial chain, and initially create an industrial chain integrating "comics - animation - games" Widely attract domestic and foreign tourists as a source of profit, enhance the competitiveness of enterprises. Increase the expenditure on game research and development and animation creation, and improve the online and offline multi-screen communication platform, so that Aofei Entertainment has a significant degree of operational capacity and non-finance. It is ahead of other enterprises and fully demonstrates the characteristics of enterprise development. Cultural Investment Holdings scored the lowest, and the operating capacity score was significantly low, reflecting that the internal asset structure of the enterprise needs to be optimized, and the financial and capital turnover situation is not good. In the background of COVID-19 epidemic, the business situation of enterprises is dismal, and the sharp depreciation of goodwill is currently a microcosm of the decline of most enterprises in China.

From the perspective of profitability, the performance of Zhongnan culture is more prominent, and its operating profit margin, net sales margin, cost and expense ratio and other indicators are also at the forefront. In addition, the operating profit margin of Zhongnan Culture is close to 169%, indicating that the sales of enterprise commodities provide more operating profits and stronger profitability. From the perspective of solvency, Dinglong culture is particularly prominent, mainly due to the large contribution of the cash flow ratio. From the perspective of operational capacity and non-financial indicators, the two indicators of Aofei Entertainment's current asset turnover rate and accounts receivable turnover ratio were outstanding. In addition, the company attaches great importance to the expenditure of scientific and technological research and development, and its innovation ability is also at the forefront. From the perspective of development capacity, the Dongwang era performed best, and the two indicators of total asset growth rate and operating income growth rate contributed the most to the enterprise. This shows that enterprises attach importance to the improvement and governance of business structure in a certain period of time, increase the injection of investment funds, speed up the expansion of asset management scale, and show the trend of rapid business expansion and market share enhancement. However, the company's operating profit growth rate indicators are relatively poor, and it should pay attention to the completion of shortcomings while developing rapidly.

3.3.3 Development trend analysis of animation industry based on K-means clustering

In the process of running the algorithm, the number of custom clusters is divided into four categories: excellent and medium difference, and the final total score data of 15 enterprises are classified. The classification results are shown in Table 4:

Table 3: Performance classification table of 15 animation enterprises

Performance results	**Classification criteria**	**Number of businesses**
outstanding	0.5≤X	Dinglong Culture, Aofei Entertainment
good	0.4≤X＜0.5	Jebsen Shares, CGT Choice, Dongwang Times, Legg Mason Culture, Huayi Brothers
qualified	0.3≤X＜0.4	Wanda Film, Chinese Film, Guangguang Media, Oriental Network, Ciwen Media, Zhejiang Wen Film, Zhongnan Culture
Non-conforming	X＜0.3	Cultural Investment Holdings

When the performance results of the enterprise are excellent, it shows that the effect of the enterprise cost control is good, the effect of asset utilization management is ideal, the allocation of capital sources is reasonable, the internal management operation of the enterprise is effective, and the investment scale can be considered in the later stage. When the performance results of the enterprise are good, it indicates that the correct business strategy has been formulated within the enterprise, and such enterprises can clarify the main business direction in the future and form a unique industrial chain to rely on technological progress and scientific management form their own competitive advantage. When the performance results of the enterprise are qualified, it indicates that the financial level of the enterprise is low. Therefore, it should pay great attention to whether the operation and management mechanism is sound, whether the research and development expenditure of the core technology is sufficient, and whether the integration of internal and external resources is reasonable. Such enterprises should increase reform and innovation, actively strengthen internal control management, and pay more attention to asset

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structure and profits allocation. When the performance result of the enterprise is unqualified, it indicates that there may be some mistakes in the management decision-making, dare not innovate the old model, have difficulties in operating turnover, and even have debt management. In the future, such enterprises should adjust the business income structure and business model according to the actual operating conditions, closely follow the direction of national policy support, launch explosive high-quality animation series products, open up product markets, appropriately reduce the business scal and reduce costs.

4. Conclusions and policy recommendations

This paper analyzes the financial performance of the animation industry, and establishes an indicator system from the five dimensions: profitability ability, solvency ability, operational ability, development ability and non-financial indicators. Fifteen animation companies were randomly selected, the entropy method was used to analyze the financial data. According to the as obtained, and the results were objective and accurate. According to the comprehensive score of each enterprise according to the indicator's weight, the K-means clustering algorithm is used to further cluster the score, and the financial performance status and future development trend of the animation industry are deeply interpreted from the four levels of classification. Therefore, the application of entropy value method and K-means clustering method has a certain reference value for the financial performance analysis of the animation industry.

Through the empirical study of the financial performance of the animation industry, this paper puts forward the following suggestions: First, enterprises should continuously improve their development strategies according to market conditions in the process of operation, pay attention to the operational efficiency and completion of internal financial work, and accelerate the upgrading of the cultural industry structure and transform the mode of economic development. Second, strengthen cultural and technological innovation, promote the new application of new technologies such as big data, cloud computing, and 5G technology in the field of animation, increase investment in key animation technologies, extend the ecological chain of the animation game industry and create an excellent original brand of animation games. Third, attach importance to the encouragement policy documents issued by the government, animation enterprises should combine the development goals at this stage, clarify their own development direction, and organically combine industrial development with regional advantages and characteristics.The development of China's animation industry is in line with the people's growing spiritual and cultural needs and the evolving market demand.

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