Evaluation method of operational effectiveness of sporting goods enterprises from the perspective of health informatics

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Abstract
The existing evaluation methods for the operational effectiveness of sporting goods enterprises do not consider the information synergy among the indexes when determining the index weight, which has a certain impact on the fitting degree of the evaluation results. This paper proposes an evaluation method for the operational effectiveness of sporting goods enterprises from the perspective of health informatics. From the four aspects of repayment ability, operation ability, profitability, and growth ability of sporting goods enterprises, this paper selects indicators to establish a rating index system. The algorithm of evaluation index information association strength is designed, and the dynamic association subgroup density and collaborative structure entropy of the index system are calculated to obtain the Information Collaborative association strength of different indexes. According to the information entropy of collaborative structure, the index weight is determined, and the evaluation model of operation effectiveness is established. The experimental results show that the proposed evaluation method is superior to the existing evaluation methods in three parameters: GFI, PGFI and NFI, which shows that the design method has a good degree of fit and can provide reference for the business evaluation of sporting goods enterprises.
Keywords: health informatics perspective; sports goods enterprises; operational effectiveness; evaluation;

1. Introduction

The sports industry has made a rare contribution to the transformation of China's industrial structure and sustained economic growth. From the implementation of "healthy China strategy" in 2015 to the proposal of "sports standardization management measures" in 2017, it indicates that the current is a good opportunity for the development of China's sports industry. The rapid development of sports industry in the new economic period benefits from the increasingly prosperous sports industry market. People's love and pursuit for sports and healthy lifestyle are increasing. The popularity of City Marathon, Winter Olympic Games and China Football League special large-scale sports events is increasing. China's market demand for sports equipment and sporting goods is also increasing. The development momentum of China's sporting goods enterprises will continue to heat up in the future (Einhorn et al., 2019). The data of the national sports industry development report jointly issued by the State General Administration of sports and the National Bureau of statistics show that the output of sporting goods accounts for more than 80% of the total output of China's sports industry, which lays the pillar position of the sporting goods industry in China's sports industry. As the leader of sporting goods industry, sporting goods enterprises are well developed, highly representative and typical. The research on them can not only comprehensively reflect the development of sporting goods industry, but also contribute to the development of China's sports industry. It also has a strong reference significance for the business management of other industries (X. Yang & Su-Sheng, 2017).

Health informatics is based on Chinese social reality and people's comprehensive demand for health, which responds to the foundation of China's deepening reform from the perspective of health governance. First of all, health informatics has a broad health connotation beyond the scope of medical treatment, which is an important foundation for China's all-round development. Health informatics includes political and economic health, institutional and cultural health, and the latter has more strategic and basic health significance, which is the ideological mechanism to realize the integration of China's health governance and global health governance. Secondly, health informatics has the connotation of cross-border construction of prevention system (Q. Yang et al., 2019). The cross-border collaboration among sports, medical and non-medical fields is the basic path of healthy China and health governance. Sports for healthy China lies in that it is a cross domain and cross-cultural health activity, which organically integrates human's natural attributes and social attributes, and is the backbone of cross-border construction of prevention system (Shao, 2019). Health is the foundation of China's development, and sports is the main strategic measure of health governance. From the perspective of health informatics, it is of great strategic significance to study the management and construction of sports industry. In order to improve the management level of sporting goods enterprises, it is necessary to accurately evaluate the operation effectiveness of sporting goods enterprises. Therefore, this paper studies the

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effectiveness evaluation method of sporting goods enterprises from the perspective of health informatics, in order to provide help for sporting goods enterprises to adjust their business strategies and operational guidelines, so as to improve the operation status and growth speed of sports listed companies, and then promote the development of China's sports industry.

2 Evaluation method of operational effectiveness of sporting goods enterprises from the perspective of health informatics

2.1 Establishment of evaluation index system

In order to evaluate the operational effectiveness of sporting goods enterprises, the evaluation index system is firstly established. For the research, the design of evaluation index system is the primary condition to correctly evaluate the effectiveness of enterprise operation (Ashrafi et al., 2019). The index system includes four aspects: repayment ability, operation ability, profitability and growth ability. Solvency index is an important index to measure the asset liquidity, credit default risk and capital structure rationality of sporting goods enterprises. Enterprises often need to operate in debt in their daily operation, so the ratio of assets to liabilities is selected as the index to consider the debt situation of enterprises (Uygur et al., 2017). The increase of liabilities will also lead to the increase of credit default risk of enterprises, and the long-term debt ratio is analyzed as a negative indicator (Ahmad & Kim, 2020). The higher the capital liquidity, the more easily the sporting goods enterprises will cash their assets to face some unexpected situations, and select the current ratio as the indicator to measure the liquidity of the enterprise assets. In addition, the higher the proportion of equity in the total assets of the evaluation unit, the weaker the probability of credit default of the enterprise, and the account payment to be repaid is guaranteed by the owner's equity (Zheng, 2017). Therefore, the proportion of debt property rights is added as an indicator to consider the risk of credit default and the degree of guarantee of the negative debt capital of sports goods enterprises. The operation turnover ability reflects the efficiency of resource utilization and the operation status of main business of sports goods enterprises. The paper selects the asset turnover rate and inventory turnover rate to measure the daily business status of the enterprise. The asset turnover rate reflects the operation state of the enterprise capital from input to output. The higher the turnover rate of the enterprise assets, the higher the efficiency of its resource utilization. The inventory turnover rate represents the management efficiency of the enterprise in terms of production and operation cycle, production batch, inventory management ability, etc. In addition, the management of accounts receivable will also affect the business operation. Add the turnover rate of accounts receivable into the index system to measure the management of accounts receivable (López-Robles et al., 2019). The turnover rate of current assets is selected to measure the liquidity in daily operation and solvency without loss of present value. The profitability of sporting goods enterprises reflects the level of income in a certain period of time. In order to consider the enterprise's profit earning ability, we comprehensively consider the return on net assets and return on assets, and analyze the net profit proportional to assets and owner's equity. At present, the situation of multi industry operation of sporting goods enterprises in China is relatively common (Zhang et al., 2017). In order to measure the profit efficiency of enterprises in the sports industry, the profit margin of main business is selected to consider the profitability of sporting goods enterprises in the main business. In addition, in order to analyze the control power and management level of cost and expense, the profit margin of cost and expense is added into the profitability index group. Growth capacity refers to the level of enterprises to expand business scale, improve management efficiency and grow in the future (Avilés et al., 2019). In the rising period, sporting goods enterprises will expand their production scale to obtain scale benefits, but the real production scale is difficult to be reflected in the financial statements. Therefore, the growth rate of total assets and capital accumulation rate are used to measure the scale expansion ratio. The higher the current asset growth rate of an enterprise, the higher its capital accumulation capacity and expansion speed. The growth rate of operating revenue is regarded as an important indicator to measure the operating efficiency of the main business.

2.2 Algorithm of information association strength of design evaluation index

The operational effectiveness evaluation system of sporting goods enterprises is an index group with certain internal relations, which can complement each other and fully reflect the operational ability of enterprises. From the perspective of health informatics, each indicator reflects different information and has certain influence. Each index is regarded as a node in the system. By calculating the relationship between the nodes, the information collaborative network structure of the evaluation system is constructed, and the influential index nodes and the correlation strength of the index information are obtained, which provides the basis for the determination of the weight of the evaluation index and the construction of the model (Wang et al., 2020). In the evaluation index system, the non-uniformity of topological structure determines that the importance of different index nodes in the network is different. The importance of the index node is measured by the influence of the node on the index system. Degree centrality analysis in network analysis method is used to identify the influence of each node in

the dynamic development of the network, that is, the importance of each node in the network (Handayani & Mahendrawathi, 2019). According to the definition, degree centrality in network analysis method is a value, which represents the number of connections from nodes in the network to other nodes in the network. The mathematical expression is as follows:

$$O(x) = \sum_{y=1}^{s} l_{x,y}(x \neq y) \quad (1)$$

In formula (1), x, y are the index node; $O(x)$ is the degree centrality of the index node in the network; s is the number of index nodes; $\sum_{y=1}^{s} l_{x,y}(x \neq y)$ is used to calculate the number of nodes x directly associated with other nodes y in the same network. By using the above measure method, the influence of the index nodes of the evaluation system of the operational effectiveness of sports goods enterprises is measured, and it is found that the nodes with strong influence are found (Froger et al., 2019). In order to get the information correlation strength between the indicator nodes, the concept of information entropy is introduced to describe the information quantity reflected by different indicators. The mathematical expression of information entropy is as follows:

$$E = -\sum_{i=1}^{m} a_i(b_i)\, log_{\alpha}\, a_i\,(b_i) \quad (2)$$

In formula (2), E represents information entropy; i is the evaluation index; m is the number of indicators; a_i is the probability of index evaluation; b_i is random variable; α is the amount of information. By calculating information entropy, it is helpful to control the information transmission reasonably. This paper proposes an algorithm of evaluating index information association intensity based on information entropy, and measures the information coordination of each index. When any two indicators produce information collaboration relationship due to business requirements, if the information quantity transmitted and received between the two parties is larger, the higher the degree of information coordination between the two indicators is considered to be higher (Zhu et al., 2020). In order to measure the information coordination degree of different indexes in the evaluation index system, the dynamic correlation subgroup density and the entropy of collaborative structure need to be obtained. The information collaboration relationship of each index in the evaluation system is in the dynamic association mode. When each index is the center of the local network of information coordination, the indicator nodes with information collaboration relationship with the central point constitute an association subgroup. By measuring the information access of the center point of the dynamic association subgroup, the density of the dynamic association subgroup can be obtained. The expression is as follows:

$$k_c = \frac{\sum_{c=1}^{u} h_c}{u} \quad (3)$$

In formula (3), k_c represents the density of the dynamic association subgroup with each node in the dynamic association subgroup as the center point; h_c is the total amount of information generated by information collaboration between the center point and other nodes in the dynamic association subgroup; u is the number of other nodes with information collaboration relationship with the center point; c is the index node. The above process can obtain the uniform density of different dynamic correlation subgroups. Because the information amount of different indicators is not constant, the density of dynamic correlation subgroups should also be non-uniform (Nam et al., 2019). For the degree of non-uniformity in the dynamic association subgroup, it can be understood as the distribution degree of information flow between the center point of the dynamic association subgroup and other nodes in the dynamic association subgroup, that is, the information synergy tendency of the center point of the dynamic association subgroup itself. Combined with information entropy, the expression of information entropy is as follows:

$$G_c = k_c\, log\, k_c \quad (4)$$

In formula (4), G_c is the cooperative structure entropy of the center point of the dynamic associated subgroup. According to the entropy of collaborative structure, the Information Collaborative tendency of evaluation index is obtained, which is the intensity of information collaboration among nodes. Based on this, the weight of each evaluation index is determined.

2.3 Determine the weight of evaluation index

There are many different evaluation criteria for the operation effectiveness of sporting goods enterprises, and these different evaluation indicators represent the processing capacity in one aspect. However, because different indicators have different weight in evaluation, we must use a systematic method to determine the specific proportion of each indicator, so as to make the evaluation more effective and objective. The index can be determined subjectively and objectively. In the subjective aspect, different indicators are usually determined according to the degree of attention. This method is simple and easy to implement. However, due to people's subjective influence, this method often lacks objectivity (Nurmadewi & Mahendrawathi, 2019). In general, the index with more information accounts for more weight. The index with less information has less weight. There are a large number of indicators in this paper. The subjective method is easily affected by various subjective aspects and cannot objectively reflect the weight ratio (Niemimaa et al., 2019). Therefore, in this paper, the objective weighting method is usually used to determine the weight. In this paper, the entropy weight of each evaluation index is determined according to the amount of information

reflected by the Information Collaborative correlation strength of each evaluation index (Martinsuo et al., 2019). The calculation process of index weight is as follows. Firstly, the indexes are normalized. The calculation formula is as follows:

$$I = \frac{I_0 - I_{0min}}{I_0 0_{min\,max}} \tag{5}$$

In formula (5), I represents the normalized index value; I_0 is the original index value; $I_{0_{min}}$ is the minimum value of index value; $I_{0_{max}}$ is the maximum value of index value. After the statistical data is standardized, the information entropy of the collaborative structure of each index can be calculated. The entropy weight of the collaborative structure information of the indicator is smaller, and the stronger the function of the comprehensive evaluation of the indicator is, the more valuable information can be obtained from the index, which makes the entropy weight larger (Garza-Reyes et al., 2019). Finally, the entropy weight of the index is calculated by the formula:

$$\omega_c = \frac{1 - G_c}{s - \sum_{c=1}^{S} G_c} \tag{6}$$

In formula (6), ω_c represents the index weight; s is the number of indicators. It can be seen from the above process that the weight of each index is calculated through the transformation of its own information, which is not affected by other factors except the data, making the weight value more reliable and objective. In addition, the standardization of data processing can effectively eliminate the differences caused by different enterprises and make the data comparable.

2.4 Establishing the evaluation model of operation effectiveness

The evaluation of operational effectiveness of sporting goods enterprises is a comprehensive comparison problem of multi evaluation objects and multi evaluation indexes. According to the different evaluation results of evaluation objects under different evaluation indexes, comprehensive analysis is often needed to get the overall better scheme. According to the general goal to be achieved and the nature of different problems, the analytic hierarchy process (AHP) decomposes the constituent factors of the problem, and hierarchizes the constituent factors according to the interrelated influence and subordinate relationship, forming a multi-level analytical structure model. Then, by layer analysis, the problem is finally reduced to the determination of the relatively important weights of the lowest layer (scheme layer) relative to the highest layer (target layer) (Zhou et al., 2019). Therefore, based on the analytic hierarchy process, this paper establishes the evaluation model of the operational effectiveness of sporting goods enterprises. The evaluation of operational effectiveness of sporting goods enterprises is a comprehensive comparison problem of multi evaluation objects and multi evaluation indexes. According to the different evaluation results of evaluation objects under different evaluation indexes, comprehensive analysis is often needed to get the overall better scheme. According to the general goal to be achieved and the nature of different problems, the analytic hierarchy process (AHP) decomposes the constituent factors of the problem, and hierarchizes the constituent factors according to the interrelated influence and subordinate relationship, forming a multi-level analytical structure model. Then, by layer analysis, the problem is finally reduced to the determination of the relatively important weights of the lowest layer (scheme layer) relative to the highest layer (target layer). Therefore, based on the analytic hierarchy process, this paper establishes the evaluation model of the operational effectiveness of sporting goods enterprises. The formula for consistency ratio is:

$$cor = \frac{coi}{rci} \tag{7}$$

In formula (7), cor is the consistency ratio; coi is consistency index; rci represents random consistency index. The larger the consistency ratio is, the more serious the inconsistency is. It can pass the consistency test, and its normalized eigenvector can be used as the weight vector. Similarly, the relative importance weight of a certain level factor to the total target (the highest level) is calculated (Kruse et al., 2019). If the total hierarchy order does not have satisfactory consistency, the element value of the judgment matrix with high consistency ratio needs to be adjusted. So far, the evaluation method of the operational effectiveness of sports goods enterprises in the view of health informatics is completed.

3 Experiment

3.1 Experimental preparation

According to the evaluation method in this paper, the weights of different levels of indicators are calculated. The details of the indicator system and the results of weighting are shown in Table 1.

Table 1

Weight of operational effectiveness evaluation index

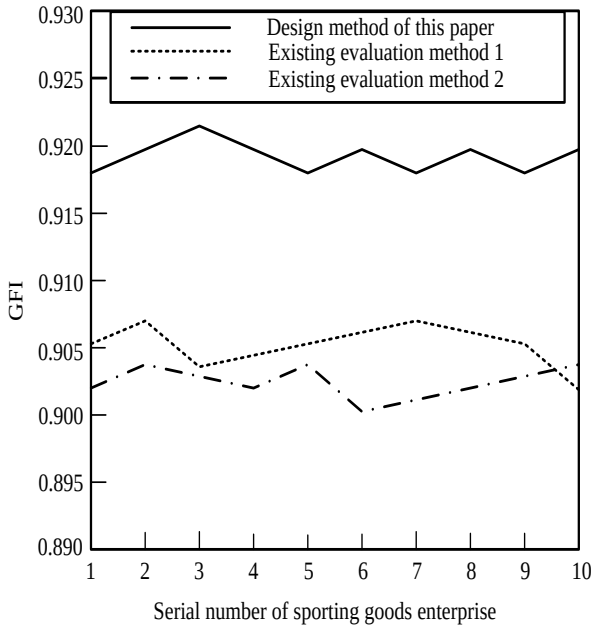
Target layer	Criterion layer	Weight	Index layer	Weight
The effectiveness of sports goods enterprises	Solvency	0.245	Asset liability ratio	0.324
			Long term debt ratio	0.286
			Debt to equity ratio	0.241

Operating capacity	0.162	Current ratio	0.149
		Asset turnover	0.362
		Accounts receivable turnover	0.216
		Inventory turnover	0.228
		Turnover of current assets	0.194
Profitability	0.459	Return on net assets	0.357
		Return on assets	0.313
		Profit margin of main business	0.166
		Cost profit margin	0.164
Growth ability	0.134	Capital accumulation rate	0.418
		Growth rate of operating revenue	0.335
		Growth rate of total assets	0.247

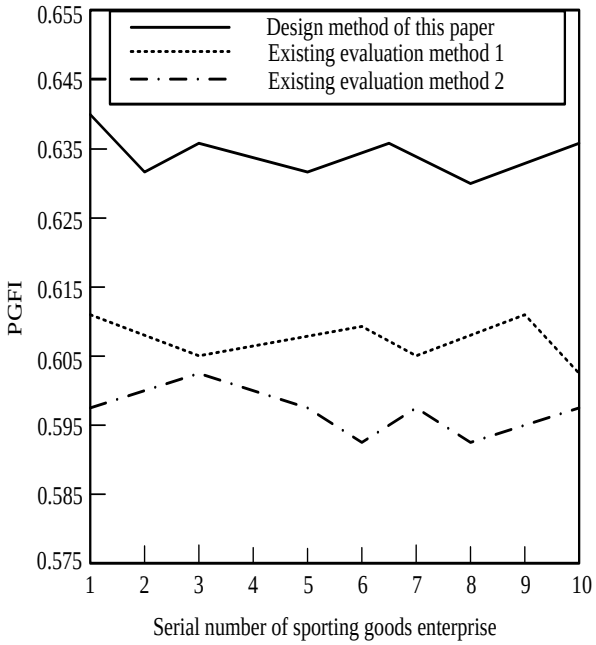
On this basis, the evaluation effect of this method is further analyzed.

2.2 Experimental results and analysis

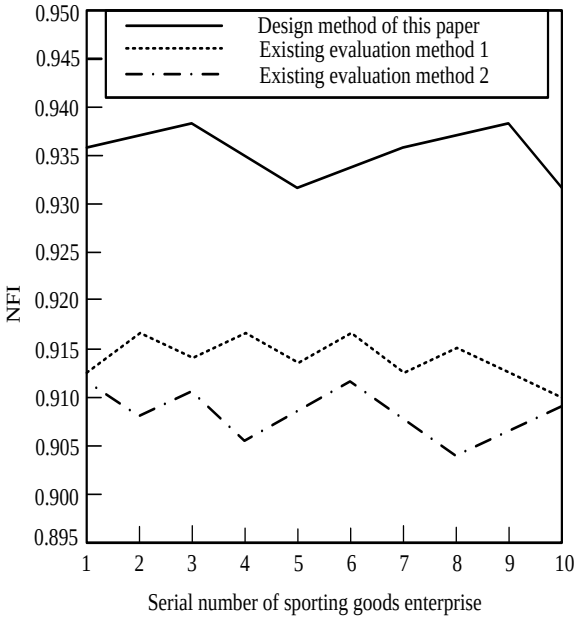
In order to verify the application effect of the evaluation method of the management effectiveness of the sports goods enterprises proposed in this paper, 10 sports goods enterprises are selected as the research object and compared with the existing evaluation methods. Fitting analysis is an effective method to measure whether the comprehensive evaluation method has stability and reliability. In this paper, the fitting goodness index GFI, the simple fit index PGFI and the standard fit index NFI are selected as the parameters to determine the fitting degree of each method, so as to detect the evaluation effect of each method. The experimental results are shown in Figure 1.



(a) GFI



(b) PGFI



(c) NFI

Figure 1 Test results

According to the test results in Figure 1 (a), the average value of goodness of fit index GFI of the design method in this paper is 0.919, which meets the condition of greater than 0.9. According to convention, this method can be accepted, while the average value of GFI of the existing method is 0.905 and 0.903, which indicates that the GFI index value of this design method is higher than that of the existing method. According to the test results in Figure 1 (b), the average value of PGFI of the design method in this paper is 0.636, and the average values of PGFI of the existing methods are 0.607 and 0.596. Therefore, the PGFI index value of this design method is higher than that of the existing methods. According to the test results in Figure 1 (c), the average value of NFI is 0.936. When the value of NFI is less than 0.9, the model needs to be reset, so the method in this paper does not need to be reset. The average NFI values of the existing methods are 0.912 and 0.909, which indicates that the NFI index value of this design method is higher than that of the existing methods. Based on the above experimental results, the evaluation method proposed in this paper is superior to the existing evaluation methods in three parameters: goodness of fit index GFI, simple fit index PGFI and standard fit index NFI. It shows that the design method has a good fit, and the set indicators can be accepted. It can be used to analyze the effectiveness of the operation of sporting goods enterprises, and has a broad application prospect.

4 Conclusion

Due to the reasons of time, energy and data collection, this paper needs further research in many aspects. First, when establishing the evaluation index system, the financial indicators selected are not necessarily the best. In the future, more indicators that can fit the connotation of various factors are adopted in the future research, so as to build a more comprehensive index system. Secondly, in the selection of relevant data, in order to ensure the authenticity and accuracy of the data used, the data used in the evaluation process are all from the annual financial reports of listed companies. Because the detailed degree of financial data disclosed by each company is different, so this paper makes a certain choice for the data. I hope that the optimization of the evaluation of the operational effectiveness of sports goods enterprises can provide new ideas for the evaluation of the effectiveness of the enterprises in various industries and promote the sustainable development of all walks of life.

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