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Research article

Budget Performance Evaluation of Public Hospitals Based on Entropy-Weighted TOPSIS Model

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ABSTRACT

In order to objectively assess the budget performance of public hospitals, this paper have utilized budget performance data from nine public hospitals in Shenzhen from 2019 to 2021 and employ the TOPSIS comprehensive evaluation method based on Entropy weight. The analysis will provide rankings for the budget performance of these hospitals. The results indicate that the top three ranked hospitals are tertiary (A) public hospitals, demonstrating relatively sound budget performance, while the bottom three ranked hospitals are primary (C) public hospitals, indicating extremely poor budget performance. Thus, the budget performance of public hospitals tends to be positively correlated with their overall strength. Further investigation reveals an imbalance in resource allocation among public hospitals, necessitating corresponding measures to promote their coordinated development.

Keywords: Budget performance, Public hospitals, Evaluation, Entropy method, TOPSIS

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Abstrak

Penelitian ini untuk menilai kinerja anggaran rumah sakit umum secara objektif. Penelitian ini telah menggunakan data kinerja anggaran dari sembilan rumah sakit umum di Shenzhen dari tahun 2019 hingga 2021 dan menggunakan metode evaluasi komprehensif TOPSIS berdasarkan bobot Entropi. Analisis tersebut akan memberikan peringkat kinerja anggaran rumah sakit tersebut. Hasilnya menunjukkan bahwa tiga rumah sakit dengan peringkat teratas adalah rumah sakit umum tersier (A), yang menunjukkan kinerja anggaran yang relatif baik, sedangkan rumah sakit yang berada di peringkat tiga terbawah adalah rumah sakit umum primer (C), yang menunjukkan kinerja anggaran yang sangat buruk. Oleh karena itu, kinerja anggaran rumah sakit pemerintah cenderung berkorelasi positif dengan kekuatan mereka secara keseluruhan. Penyelidikan lebih lanjut mengungkapkan adanya ketidakseimbangan dalam alokasi sumber daya di antara rumah sakit umum, sehingga memerlukan tindakan yang tepat untuk mendorong pengembangan terkoordinasi.

Kata Kunci: Kinerja Anggaran, Rumah Sakit Umum, Evaluasi, Metode Entropi, TOPSIS

1. Introduction

Public hospitals, primarily supported by the government, operate as non-profit healthcare institutions with a mission to provide inclusive medical services. The government invests substantial resources in the construction of public hospitals to ensure that a greater number of people have access to high-quality healthcare. Urgency: In recent years, with the increasing complexity of healthcare services and continuous development of medical technology, public hospitals are encountering increasingly severe financial pressures and resource constraints. In such an environment, budget performance evaluation has become a critical component of public hospital management. Budget performance evaluation not only concerns the financial condition of public hospitals but also directly affects the quality and efficiency of healthcare services. Therefore, a comprehensive assessment of the budget performance of public hospitals is urgently needed.

Although budget performance evaluation is crucial for the management of public hospitals, there are currently some analytical gaps that need to be addressed. Traditional evaluation methods often exhibit strong subjectivity and insufficient indicator selection, failing to comprehensively and objectively reflect the actual situation of hospitals. This leads to a certain degree of uncertainty and limitations in the accurate evaluation budget performance of public hospitals. In this paper, we propose an integrated Entropy-Weighted-TOPSIS method based on multi-attribute decision theory, incorporating the concepts of information entropy and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) to evaluate budget performance of public hospitals. The Entropy-Weighted-TOPSIS method considers the importance of different indicators and identifies the optimal solution by ranking the relative values of indicators, thereby enhancing the objectivity and accuracy of the evaluation results. Therefore, applying the Entropy-Weighted TOPSIS method to budget performance evaluation in public hospitals can help comprehensively assess hospital performance and provide a scientific basis for management decisions. Research Objectives: This paper aims to propose a comprehensive and scientific framework for evaluating the budget performance of public hospitals, and provide valuable insights and management recommendations for decision-makers, thereby facilitating continuous improvement and enhancement of healthcare services.

In the healthcare sector, the implementation of budget performance evaluation is crucial for the development of both the health departments and healthcare institutions. Researches have shown that active involvement of health departments in the process of budget

performance evaluation can facilitate alignment of budget allocations with national health strategies and priorities (Naranjee, Sibiya, & Ngxongo, 2019). Moreover, many countries have initiated budget performance evaluation reforms in the healthcare domain (Kosherbayeva et al., 2020). Budget performance evaluation serves as a top-down management tool that links measurable data outcomes with public funds allocated to public hospitals, establishing a connection between budget resources and performance assessment (Hodkinson et al., 2022). However, to truly enhance overall hospital performance, there is a need for a more scientific and objective evaluation method to guide rational allocation and management of resources (Collier, 2020).

Integrating the entropy-weighted TOPSIS method into the budget performance evaluation system of public hospitals, the entropy-weighted TOPSIS method objectively evaluates the budget performance of public hospitals by determining appropriate evaluation indicators, collecting relevant data, calculating weights, and distance values, and provides some improvement suggestions (Xin, Yang, Yang, Li, & Wei, 2017). It can simultaneously consider the relationships among multiple variables, comprehensively assess the impact of various indicators on budget performance, and thus derive more comprehensive evaluation results (Banadkouki, 2023). The TOPSIS model is a multi-attribute decision-making method that determines the best solution by comparing the similarity between decision objects and ideal and non-ideal solution (Shi & Sun, 2023). Traditional evaluation processes often assume that each indicator exists independently, which is not applicable to budget performance indicators with high correlation (Liew, Lam, & Lam, 2022). Additionally, when using methods such as the Delphi method, principal component analysis, or Analytic Network Process (ANP) to determine weights, there is often strong subjectivity, affecting the reliability of the evaluation results (Tiwari, Sherwani, Muqeem, & Goyal, 2022; Zhou, Lim, He, & Pratap, 2020).

Different choices of research objects and methods in different studies may lead to certain differences in evaluation results, but overall, they can provide important references and insights for the performance management of public hospitals (Dehdasht, Ferwati, Zin, & Abidin, 2020; Zhou, Lin, Wang, Zhou, & He, 2016). Future research can further expand the application scope of the entropy-weighted TOPSIS method in hospital performance evaluation, explore more effective combinations of evaluation indicators and methods, and enhance the scientific and practicality of evaluation results (Arya & Kumar, 2021; He, Wang, Lin, & Zhou, 2016; He, Wang, Lin, Zhou, & Zhou, 2017).

2. Method

Data Source

The data in this research mainly come from internal statistical data of public hospitals (2019-2021), patient satisfaction survey data (2019-2021), employee satisfaction survey data (2019-2021), financial statement data of public hospitals (2019-2021), and some data are calculated using relevant formulas. In China, public hospitals are typically categorized into three levels based on their service capacity and medical standards: Tertiary (A), Secondary (B), and Primary (C). These standards reflect differences in the hospitals' overall strength and capabilities. In this research, the representative samples are as follows: The Tertiary (A) public hospitals are Shenzhen Yantian District People's Hospital, Shenzhen People's Hospital, and Shenzhen Third People's Hospital. The Secondary (B) public hospitals are Shenzhen Futian District Maternal and Child Health Hospital, Shenzhen Baoxing Hospital, and Shenzhen Pingshan District People's Hospital; The Primary (C) public hospitals are Shenzhen Longxiang Hospital, Shenzhen Overseas Chinese Town Hospital, and Shenzhen Port Hospital.

Construction of Evaluation Indicator System

According to relevant theories and literature, this article considers social contribution, patient satisfaction, internal business processes, and learning and growth as the four criteria layers of the indicator system. Based on the construction principles, 16 specific indicators were selected to represent the budget performance evaluation of public hospitals. The evaluation indicator system of public hospitals is shown in Table 1 below.

Table 1. Budget Performance Evaluation Indicator System for Public Hospitals

Objective Layer	Criterion Layer	Indicator Layer	Symbols
Budget Performance Evaluation of Public Hospitals	Social Contribution	hospital annual outpatient revenue	C1
		hospital inpatient revenue	C2
		hospital gearing ratio	C3
		hospital drug expenditure	C4
	Patient Satisfaction	patient positive rating	C5
		patient return rate	C6
		hospital patient complaint rate	C7
		hospital medical compensation rate	C8
	Internal Business Process	access process score	C9
		grade a medical record rate	C10
		hospital patient cure rate	C11
		hospital diagnostic compliance rate	C12
	Learning and Growth	new project development in scientific research	C13
		The output of scientific achievements	C14
		staff satisfaction	C15
		staff annual training hours	C16

Determination of Indicator Weights

Entropy is a parameter that characterizes the state of matter, where a greater information entropy indicates that the indicator provides more useful information in the system and has a higher degree of dispersion. Thus, the weight of the indicator in the studied problem is also greater. Therefore, by studying the information entropy of variables, the weights of each variable can be objectively determined, providing an objective basis for comprehensive

evaluation. Entropy weight method is an objective assignment method, which gives each indicator a reasonable weight through rigorous mathematical calculation, providing an objective basis for constructing comprehensive indicators

Step 1: Using vector normalization method to construct the decision matrix

The entropy weight method is a technique that determines the weight of indicators based on the degree of variation of the indicators. This method retains the characteristics of the original data, thus resulting in objective weights. By standardizing the raw data, a standardized matrix is obtained: $\mathbf{R} = (\mathbf{r_{ij}})_{\mathbf{m*n}}$;where i =1,2...m ;and j =1,2,...n, , $\mathbf{r_{ij}}$ represents the standardized value of the $\mathbf{i}$ corresponding to the $\mathbf{j}$ evaluation object, $\mathbf{m}$ denotes the number of research objects, and $\mathbf{n}$ is the number of indicators.

Step 2: Calculate the proportion of the standardized value $\mathbf{P_{ij}}$ of the $\mathbf{j}$ indicator for the $\mathbf{i}$ evaluation object.

$$\mathbf{P_{ij}} = \frac{\mathbf{r_{ij}}}{\sum_{\mathbf{i=1}}^{\mathbf{i=m}} \mathbf{r_{ij}}} \tag{1.1}$$

Step 3: Calculate the information entropy for the $\mathbf{j}$ indicator.

$$\mathbf{e_j} = -\frac{\mathbf{1}}{\ln \mathbf{n}} \sum_{\mathbf{i=1}}^{\mathbf{n}} \mathbf{p_{ij}} \ln(\mathbf{p_{ij}}) \quad (\mathbf{j = 1, 2, \ldots m}) \tag{1.2}$$

From Equation (1.2), we can derive the information utility value.

$$\mathbf{d_j} = \mathbf{1} - \mathbf{e_j} \tag{1.3}$$

Step 4: Normalize the information utility values to determine the entropy weight for each indicator.

$$\mathbf{W_j} = \mathbf{d_j} \Big/ \sum_{\mathbf{i=1}}^{\mathbf{i=m}} \mathbf{d_j} \quad (\mathbf{j = 1, 2, \ldots, m}) \tag{1.4}$$

Construction of the TOPSIS Evaluation Model

The TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) comprehensive evaluation method ranks the advantages and disadvantages of various solutions based on their proximity to both the ideal solution and the worst solution. The solution closest to the ideal solution is selected as the target solution. The steps based on TOPSIS are as follows:

Step 1: Calculate the average evaluation value of the hospital budget performance of the alternatives

Let us consider a set of m of the sample public hospital $A = \{A_1, A_2, \ldots, A_m\}$ that are evaluated based on n indicators $C = \{C_1, C_2, \ldots, C_n\}$. The hospital's budget performance values are defined as available. Set $\mathrm{a_{kij}}$ is hospital budget performance evaluation result of experts $\mathrm{E_k(k = 1,2, \ldots, r)}$ for each the sample public hospital $\mathrm{A_i(i = 1,2, \ldots, m)}$ about the indicator $\mathrm{C_j(j = 1,2, \ldots, n)}$. Then the average hospital budget performance values can be obtained by:

$$\bar{a}_{ij} = (1/r) * (\textstyle\sum_{k=1}^{r} a_{kij}) \tag{2.1}$$

Based on the Questionnaire C entries, experts $\mathrm{E_k(k = 1,2, \ldots, r)}$ scored the budget implementation indicators of each sample public hospitals. The sum of all experts' scores is

calculated, then divided by the number of experts. Thus the initial decision matrix can be derived by obtaining the average values.

Step 2: Build the initial decision matrix

According to (2.1), we can obtain the initial decision matrix by:

$$A = (a_{ij})_{m*n} = \begin{bmatrix} \bar{a}_{11} & \cdots & \bar{a}_{1n} \\ \vdots & \ddots & \vdots \\ \bar{a}_{m1} & \cdots & \bar{a}_{mn} \end{bmatrix} \quad (2.2)$$

Step 3: The decision matrix is normalized as follows

The normalized treatment is defined as:

$$b_{ij} = \frac{\bar{a}_{ij} - Min\{\bar{a}_{ij}, i=1,2,\ldots,m\}}{Max\{\bar{a}_{ij}, i=1,2,\ldots,m\} - Min\{\bar{a}_{ij}, i=1,2,\ldots,m\}} \forall j = 1,2,\ldots,n \quad (2.3)$$

This formula scales the scores to a range between 0 and 1. These normalization procedures ensure all indicators are on the same scale, allowing them to be combined and compared in a decision-making process.

Then, the normalized decision matrix *B* can be expressed as

$$B = (b_{ij})_{m*n} = \begin{bmatrix} b_{11} & \cdots & b_{1n} \\ \vdots & \ddots & \vdots \\ b_{m1} & \cdots & b_{mn} \end{bmatrix} \quad (2.4)$$

Step 4: Obtain the decision matrix with normalized weights by equation

$$C = (c_{ij})_{m*n} = \begin{bmatrix} W_1 * b_{11} & \cdots & W_n * b_{1n} \\ \vdots & \ddots & \vdots \\ W_1 * b_{m1} & \cdots & W_n * b_{mn} \end{bmatrix} \quad (2.5)$$

The weights W1…Wn use the coefficients of the visible variables on budget performance derived using the AHP.

Step 5: Calculate the distance to the ideal substitute for the positive and negative sides

Step 5.1: Select the positive ideal choice and the opposing choice.

Let C_+ and C_- represent the ideal positive and ideal negative choices. Then they can be expressed as follows:

$$C_+ = \left(c_j^+\right) = \left\{\left(\max_i c_{ij} \middle| j \in J_1\right), \left(\min_i c_{ij} \middle| j \in J_2\right)\right\} \quad (2.6)$$

$$C_- = \left(c_j^-\right) = \left\{\left(\min_i c_{ij} \middle| j \in J_1\right), \left(\max_i c_{ij} \middle| j \in J_2\right)\right\} \quad (2.7)$$

J_1 is the set of benefit-based indicators, and J_2 is the set of cost-based indicators.

Step 5.2: Calculate the Euclidean distance from the ideal positive and ideal negative values, using the respective formulas:

$$\mathrm{d}_i^+ = \left[\sum_{j=1}^{m}\left(C_{ij} - C_j^+\right)^2\right]^{0.5} \quad (2.8)$$

$$\mathrm{d}_i^- = \left[\sum_{j=1}^{m}\left(C_{ij} - C_j^-\right)^2\right]^{0.5} \quad (2.9)$$

Step 6: Calculate the relative proximity values pertaining to the Performance Score R_i:

$$R_i = \frac{\mathrm{d}_i^-}{d_i^+ + d_i^-} \quad (2.10)$$

The Performance Score, $\mathrm{R_i}$ is a value between 0 and 1 inclusive, that is, $0 \leq R_i \leq 1$.

Step 7: Classify the alternatives

Based on the performance scores obtained in Step 6, we ranked the alternatives on the scale that the larger the value, the better the hospital's budget performance. The value of $\mathrm{R_i}$ then was interpreted based on the following scale.

Table 2. Interpretation of the relative proximity, R_i

$\mathrm{R_i}$	Evaluation	Budget Performance(Chowdhury & Turin, 2020)
0.70~1.0	Excellent	The hospital excels across all criteria; it maintains high levels of patient satisfaction, delivers top-notch medical quality, and actively pursues innovation and improvement.
0.40~0.69	Good	The hospital performs well in multiple criteria, but there may be room for improvement in some areas.
0.00~0.39	Poor	The hospital performs poorly across multiple criteria, potentially exhibiting financial wastage, low patient satisfaction, and subpar medical quality, among other issues.

3. Results and implications

Determine Weights Using The Entropy Weighting Method

Based on actual data, before applying the entropy method to the indicators C1, C2,...C16, normalize the data using the generated variable function. Utilize the entropy method to calculate weights for all 16 items such as C1, and so forth. Subsequently, input the weights into equation (1.2) to compute the information entropy value e. Following equation (1.3), determine the information utility value d, then normalize the information utility values. Finally, according to equation (1.4), ascertain the entropy weight W for each indicator. Further, through R programming language, the weights of each indicator in the budget performance of public hospitals can be computed as shown in Table 3.

Table 3. Calculation of Weight Coefficients Using Entropy Method

Variables	Information Entropy Value (e)	Information Utility Value (d)	Weight Coefficient (w)
C1	0.9975	0.0025	0.0436
C2	0.9970	0.0030	0.0513
C3	0.9968	0.0032	0.0556
C4	0.9969	0.0031	0.0534
C5	0.9955	0.0045	0.0780
C6	0.9953	0.0047	0.0821
C7	0.9959	0.0041	0.0717
C8	0.9959	0.0041	0.0715
C9	0.9969	0.0031	0.0537
C10	0.9962	0.0038	0.0662
C11	0.9958	0.0042	0.0719
C12	0.9954	0.0046	0.0793
C13	0.9970	0.0030	0.0511
C14	0.9975	0.0025	0.0426
C15	0.9959	0.0041	0.0703
C16	0.9967	0.0033	0.0577

From Table 3, it can be observed that there are a total of 16 items, denoted as C1 to C16, with respective weight values of 0.0436, 0.0513, 0.0556, 0.0534, 0.0780, 0.0821, 0.0717, 0.0715, 0.0537, 0.0662, 0.0719, 0.0793, 0.0511, 0.0426, 0.0703, and 0.0577. Furthermore, the weights among these items are relatively uniform, all around 0.062.

Evaluate the Budget Performance of Public Hospitals Using the TOPSIS Model

We obtain the budget performance results according to TOPSIS method described in Section 2.4, and the results in details is as follows:

Calculate the Euclidean distances between the budget performance and the positive and negative ideal solutions, as well as the degree of closeness (d_i) to the positive ideal solution. d_i value closer to 1 indicates that the budget performance of the public hospital is closer to the positive ideal solution, while d_i value closer to 0 indicates that the budget performance of the public hospital is further from the positive ideal solution. Then the positive and negative ideal solutions are obtained based on Equation (2.1) – (2.9) seen in Table 4 and Table 5.

Table 4. Positive ideal solutions

	Budget Performance Indicators															
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16
H1	0.0002	0.0000	0.0003	0.0000	0.0004	0.0000	0.0012	0.0016	0.0000	0.0007	0.0001	0.0003	0.0000	0.0003	0.0005	0.0002
H2	0.0001	0.0000	0.0009	0.0002	0.0000	0.0000	0.0012	0.0002	0.0000	0.0008	0.0000	0.0006	0.0000	0.0002	0.0004	0.0005
H3	0.0000	0.0001	0.0031	0.0029	0.0015	0.0006	0.0000	0.0000	0.0000	0.0000	0.0023	0.0000	0.0001	0.0018	0.0000	0.0000
H4	0.0003	0.0002	0.0003	0.0001	0.0018	0.0039	0.0003	0.0004	0.0005	0.0015	0.0027	0.0007	0.0017	0.0002	0.0006	0.0006
H5	0.0006	0.0000	0.0004	0.0004	0.0007	0.0034	0.0009	0.0003	0.0006	0.0015	0.0016	0.0016	0.0012	0.0003	0.0007	0.0007
H6	0.0001	0.0002	0.0004	0.0004	0.0001	0.0015	0.0008	0.0010	0.0002	0.0014	0.0008	0.0014	0.0009	0.0003	0.0009	0.0005
H7	0.0019	0.0015	0.0000	0.0001	0.0034	0.0000	0.0051	0.0051	0.0029	0.0044	0.0052	0.0063	0.0000	0.0000	0.0049	0.0033
H8	0.0009	0.0020	0.0010	0.0025	0.0055	0.0067	0.0031	0.0022	0.0010	0.0015	0.0036	0.0016	0.0026	0.0007	0.0007	0.0005
H9	0.0005	0.0026	0.0014	0.0001	0.0061	0.0028	0.0012	0.0014	0.0005	0.0017	0.0041	0.0007	0.0022	0.0006	0.0009	0.0005

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Table 5. Negative ideal solutions

	Budget Performance Indicators															
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16
H1	0.0009	0.0024	0.0014	0.0029	0.0034	0.0067	0.0014	0.0010	0.0029	0.0015	0.0041	0.0038	0.0022	0.0006	0.0023	0.0018
H2	0.0012	0.0026	0.0006	0.0015	0.0061	0.0060	0.0014	0.0032	0.0027	0.0014	0.0052	0.0031	0.0022	0.0009	0.0025	0.0012
H3	0.0019	0.0016	0.0000	0.0000	0.0015	0.0034	0.0051	0.0051	0.0029	0.0044	0.0006	0.0063	0.0016	0.0000	0.0049	0.0033
H4	0.0007	0.0015	0.0014	0.0018	0.0012	0.0004	0.0028	0.0027	0.0010	0.0007	0.0004	0.0029	0.0001	0.0008	0.0021	0.0011
H5	0.0004	0.0024	0.0013	0.0012	0.0026	0.0006	0.0017	0.0029	0.0008	0.0007	0.0010	0.0016	0.0003	0.0006	0.0020	0.0010
H6	0.0011	0.0013	0.0013	0.0012	0.0049	0.0019	0.0019	0.0016	0.0014	0.0008	0.0019	0.0017	0.0004	0.0007	0.0017	0.0012
H7	0.0000	0.0002	0.0031	0.0018	0.0004	0.0067	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0026	0.0018	0.0000	0.0000
H8	0.0002	0.0000	0.0005	0.0000	0.0000	0.0000	0.0003	0.0006	0.0005	0.0007	0.0001	0.0016	0.0000	0.0003	0.0020	0.0012
H9	0.0005	0.0000	0.0003	0.0021	0.0000	0.0008	0.0014	0.0012	0.0010	0.0006	0.0001	0.0029	0.0000	0.0004	0.0017	0.0013

At last, we use Equation (2.10) to obtain the relative closeness of alternative to the ideal solution as follows:

Table 6. Relative closeness values of sample public hospitals

Sample Hospitals	Relative closeness	Rank
H1	0.7224	2
H2	0.7388	1
H3	0.6496	3
H4	0.5382	6
H5	0.5440	5
H6	0.6036	4
H7	0.3798	8
H8	0.3208	9
H9	0.4201	7

Discussion

The Researcher categorized the budget performance evaluation criteria for public hospitals into three categories: excellent, good, and poor (see Table 2), with corresponding ranges as follows: excellent [0.70-1], good [0.40-0.70], and poor [0.00-0.40]. The table 8 illustrated the scoring and final ranking of overall budget performance for public hospitals based on research results. The results indicate that among these 9 public hospitals, H2 achieved the highest budget performance score of 0.7388, securing the top position. Following closely behind is H1, with a budget performance score of 0.7224, ranking second. Both hospitals achieved significant results in social contribution, patient satisfaction, internal business processes, and learning and growth. However, H8 scored only 0.3208 in budget performance, and H7 scored 0.3798, ranking the lowest in overall budget performance evaluation. This indicates that public hospitals H7 and H8 face challenges in internal business processes and patient satisfaction, particularly in employee training hours, resulting in relatively low budget performance scores and rankings. Other public hospitals such as H4, H5, and H6 scored 0.5382, 0.5440, and 0.6036, respectively, showing moderate performance. The low score in research output suggests unsatisfactory research outcomes. Hospitals should organize regular academic lectures and seminars, inviting renowned experts from home and abroad to share cutting-edge medical knowledge and clinical experience. Although not reaching the highest level, the considerable difference from the lowest level indicates a certain balance in budget performance management and room for improvement. Overall, this study provides applicable insights for public hospital managers and government officials, aiding them in formulating policies to enhance the budget performance and service quality of public hospitals.

Using the TOPSIS comprehensive assessment method based on the entropy weight method, positive and negative ideal solutions, and rankings of budget performance for public hospitals at three levels (tertiary, secondary, and primary) are obtained. Additionally, Table 7 reveals that tertiary(A) public hospitals demonstrate the most comprehensive budget performance, followed by secondary(B) public hospitals and primary(C) public hospitals. In relative terms, tertiary(A) public hospitals possess more resources and the richer talent pool, enabling them to deliver higher-quality medical services and achieve better budget performance. Thus, the budget performance of public hospitals is closely linked to their overall strength.

Table 7. Relative closeness values of three levels public hospitals

Sample Hospitals	Positive ideal solutions	Negative ideal solutions	Relative closeness	Rank
Tertiary (A) public hospitals	0.2598	0.6091	0.7010	1
Secondary (B) public hospitals	0.3521	0.4509	0.5615	2
Primary (C) public hospitals	0.5647	0.3376	0.3742	3

4. Conclussion

The research proposes a TOPSIS method based on entropy weighting, which simplifies the construction steps of the budget performance comprehensive evaluation model of the decision matrix by normalizing and standardizing the decision matrix, making the calculation process simple and fast. At the same time, the model uses information entropy for objective weighting to reduce errors caused by subjective weighting. Applying the TOPSIS model based on variables normalization and entropy weighting to the comprehensive evaluation of budget performance in nine public hospitals, it can not only evaluate the relative merits of social contribution, patient satisfaction, internal business processes, learning and growth, but also reflect the ranking of budget performance comprehensive evaluation of public hospitals, demonstrating good practicality.

The positive and negative ideal solutions for budget performance of public hospitals in Shenzhen are determined using the TOPSIS comprehensive evaluation method based on the Entropy Weight method. Furthermore, from Table 6, it can be observed that hospitals H1-H3 exhibit the best budget performance, followed by H4-H6 and H7-H9. from Table 7, H1-H3 precisely correspond to the selected positive ideal solution, while H4-H6, although ranking second, only have a closeness degree of 0.3742 to the positive ideal solution. This indicates that the budget performance of secondary (B) public hospitals still significantly differs from that of tertiary (A) public hospitals. The main reason for this ranking is the close relationship between the budget performance of public hospitals and their overall strength. Tertiary(A) public hospitals typically have more resources, including funds, human resources, and facilities. This enables them to better allocate and manage resources to provide higher-quality medical services. Additionally, Tertiary (A) public hospitals often have more medical specialists and researchers who possess richer clinical experience and professional knowledge. The level and quantity of these medical staff directly impact the hospital's performance, enabling them to provide higher-level medical services and thus improve budget performance.

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