

The Evaluation of the Business Operation Performance by Applying Grey Relational Analysis

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Abstract. The effect of the business operation performance has a great influence on the growth and development of a corporation; therefore, the purpose of measuring the business operation performance is to understand whether the application and allocation of the resources in a corporation have reach the optimality and the completeness progress of goals, and these all provide the management with the essential information as valuable references for possible correction plans or policy decisions with a view to enhancing business competitiveness. Furthermore, investors are able to develop judgment of investment according to the results of evaluating the business operation performance. Takes 9 tourist hotels in Taiwan as study objects, collect related financial data in 2012 from Taiwan Stock Exchange (TWSE) and designate 6 financial ratios—Current Ratio, Fixed assets turnover ratio, Debt Ratio, Return on Equity (ROE), Growth Rate of Operating Income and Account Receivable Turnover Ratio—as evaluation indicators. By applying the method of Grey Relational Analysis, we obtained the grades of performance evaluation of the 9 objects and then arranged them in order. Afterwards, according to the ranking and through comparison among the evaluation results of the 9 corporations, we found the best corporate as a “Benchmark”, which is to be a model for other companies in the same industry and to serve as good reference for general inventors when making investment decisions.

Keywords: Performance Evaluation, Grey Relational Analysis, Benchmarking, Financial Indicators.

1 Introduction

Business operating performance is always being taken as an essential indicator of corporation development, for the management, through the evaluation of operating indicator, can fully realize the efficiency and effectiveness of operation of enterprise resources, then locating problems and adjusting operation policies accordingly, so as to gain more competitive advantages. From that reason, an enterprise must deliberately and objectively evaluate business operating performance of itself to be sure of

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future business growth and optimistic development and to reduce the risk of incorrect investment decisions. The public is always greatly concerned about an enterprise's financial performance and look upon it as an indicator of whether to invest, for this indicator is to help them select desirable investment targets with high profitability and growth dynamic and receive better returns in stock market.

This study took 9 tourist hotels as study objects and applied the method of Grey Relational Analysis to analyze their financial data, which are open resources and available to the public, and to evaluate business operating performances of each. With the performance evaluation results, not only is the public capable of having a clear idea about an enterprise's financial status and state of operation, but corporations also acquaint themselves with where they are in the industry by comparing relative operating performance with others and find out the best enterprise as the benchmark, a model to imitate and learn from.

According to the study purposes, the following is the content of the study: (1) Settle the sample data of the study—9 tourist hotels as the study objects. (2)select the financial-related indexes and acquire data needed from the open financial statements in 2012 from Taiwan Stock Exchange (TWSE). (3)Get an order list of business operating performance from the outputs calculated by applying Grey Relational Analysis. (4) Compare the ranking of business operating performance of each enterprise and analyze the differences among them to discover the best one to be the “benchmark”, which is to be the model of other corporations in the same filed or industry and to provide the general investors with the reference basis when making investment decision.

2 Literature Review

2.1 Evaluation of Business Operating Performance

The importance of performance in management is beyond doubt. Early scholars considered performance the measure of the completeness of goals in an organization, which consists of efficiency and effectiveness. Efficiency is to select optimal action plans and use correct methods to achieve designated aims; effectiveness is the rate of achievement of goals. In brief, the true meaning of performance in management lies in how to achieve the goals of an organization and enhance the effectiveness of it through the powers from people or groups.

However, nowadays, opinions are widely divided regarding the measure of performance. Some studies took financial indexes such as return on investment and profitability as the standards of performance evaluation, while others used qualitative data such as productivity, organization commitment and working satisfaction of employees to explain the business operating performance of a company. Venkatraman and Ramanujam (1986) [18] stated the measuring of business performance can be divided into three catalogues—financial performance indicator (the amount of sales growth), operating performance indicator and organizing performance indicator. Financial performance indicator is the most widely used concept. As for operating performance indicator, in addition to the concept of financial performance indicators, it involves

non-financial performance indicators such as market shares, product quality, introduction of new products and the creating of additional value. Considering the date and information from financial statements made by enterprises are more objective and less controversial, the study uses the financial indicators as the measure of business operating performance.

Scholars have performed many studies related to the evaluation of business operating performance, and they used different financial ratio variables, analytical method and study samples for difference study subjects. Yang et al. (1999) [20] took financial ratios as study variables to establish prediction model of financial crisis of enterprise. Feng and Wang (2000) [12] used financial ratios to evaluate the performance of aviation industry. From above reference documents, the analysis of financial ratios truly an effective tool to measure the operating performance of enterprises or to predict the possible failure of them. Financial statements not only provide the information for measuring operating performance but also contribute to planning current or future activities and even works well as a reference basis for future decisions.

2.2 Benchmarking

The concept of benchmarking is about finding out the outstanding corporation in an industry and regard it as a model to improve the process performance and competitive advantages by learning its goodness and strengths. American Productivity and Quality Center (APQC) (1993) [1] defined benchmarking as “a systematic and continuous process of measuring. By assessing practices of the best-in-class, determine the extent to which they might be adapted to achieve superior performance.”

From the above definitions, we knew benchmarking aims to improve running performance of enterprise. By accessing and implementing the best practice in the field, we derive action plans to improve our weakness and defects. As Boxwell (1994) [2] said, the main purpose of enterprises’ practicing benchmarking is to root out the problems in business running and seek for solutions. Codling (1998) [3] suggested that enterprises focus on the parts which can bring up the most benefits by practicing benchmarking.

3 Research Methods

3.1 The Selecting of Study Objects and the Evaluation Indexes of Performance

The study objects of this study are 9 tourist hotels in Taiwan, evaluated for operating performance through analyzing financial statements in 2012, which are open and available to the public in Taiwan Stock Exchange (TWSE). Seeing that financial ratios indicate the performance an enterprise practices during a period of time and also offer a better picture of what an enterprise’ health looks like. Thus, as Venkatraman and Ramanujam (1986) [18] conducted, this study also mainly uses financial ratios to analyze the data and information collected and takes them as measures of performance. In selecting indicators, after reviewing related documents and discussions

with scholars and experts in the field, This study probes into business operation performance from 6 significant financial ratios—solvent capability, asset management, financial structure, profitability, growth capability, activity capability, organized as Table 1 below.

Table 1. Indicators of performance evaluation

Dimensions of Performance	Measuring indicators	Definitions
Solvent capability	Current ratio	Current ratio=current asset / current liability
Asset management	Fixed assets turnover ratio	Fixed assets turnover ratio= net sales / average net fixed assets
Financial structure	Debt ratio	Debt ratio=Total liabilities / Total assets
Profitability	Return on Equity (ROE)	ROE=Net income after taxes / average equity
Growth capability	Operating income growth rate	Operating income growth rate = current operating income / former operating income
Activity capability	Account receivable turnover ratio	Account receivable turnover ratio =net sales / average account receivable

Sources: This research summarized

3.2 Principles of Grey Relational Analysis (GRA)

The Grey System theory was proposed by Deng in 1982 [8], and has proven useful for dealing with poor quality, incomplete, and uncertain data. A grey system is a system which contains insufficient information [14], and the theory is enormously popular due to its ability to work with these problems of uncertainty, multi-input, discrete data and not enough data. Grey relational analysis [9] is one of two mainstays for the grey system theory. The GRA can be used to capture the correlations among factors and candidates of a system. One of the advantages of GRA is that the quantitative and qualitative relationships can be identified from numerous factors with insufficient information. Many traditional mathematic correlations analyses can render not only coefficients among factors but also relevant levels [4]. In the following, we briefly review some definitions of grey relational analysis from [4,11,13,15]. These basic definitions and notations below will be used throughout the paper unless otherwise stated.

Definition 1. Let the original reference sequences and comparability sequences be noted as $x_0^{(0)}(k)$ and $x_i^{(0)}(k), i=1,2,\dots,n; k=1,2,\dots,m$, respectively. Here, the original reference sequence and comparability sequences can be expressed as Eq.(1) and Eq.(2):

$$x_0^{(0)} = \{x_0^{(0)}(k)\} = (x_0^{(0)}(1), \dots, x_0^{(0)}(m)) \in X, k = 1, 2, \dots, m \tag{1}$$

$$x_i^{(0)} = \{x_i^{(0)}(k)\} = (x_i^{(0)}(1), \dots, x_i^{(0)}(m)) \in X \tag{2}$$

$i = 1, 2, \dots, n; k = 1, 2, \dots, m$

Definition 2. If the target value in original sequence has the characteristic of “the-larger-the better”, the original sequence will be noted as follows: [19]

$$x_i^*(k) = \frac{x_i^{(0)}(k) - \min x_i^{(0)}(k)}{\max x_i^{(0)}(k) - \min x_i^{(0)}(k)} \tag{3}$$

When the value is “the-smaller-the better”, the original sequence can be denoted as follows:

$$x_i^*(k) = \frac{\max x_i^{(0)}(k) - x_i^{(0)}(k)}{\max x_i^{(0)}(k) - \min x_i^{(0)}(k)} \tag{4}$$

Rather, if the target value (*OB*) is specified between the maximum and the minimum, the original sequence is defined in this form:

$$x_i^*(k) = 1 - \frac{|x_i^{(0)}(k) - OB|}{\max\{\max[x_i^{(0)}(k)] - OB, \min[x_i^{(0)}(k)]\}} \tag{5}$$

Definition 3. The grey relational coefficient can be defined as follows:

$$\xi(x_i^{(0)}(k), x_j^{(0)}(k)) = \frac{\Delta_{\min.} + \rho\Delta_{\max.}}{\Delta_{ij}(k) + \rho\Delta_{\max.}} \tag{6}$$

$$\Delta_{\max.} = \max_{\forall_i} \max_{\forall_j} \|x_i^{(0)}(k) - x_j^{(0)}(k)\| \tag{7}$$

$$\Delta_{\min.} = \min_{\forall_i} \min_{\forall_j} \|x_i^{(0)}(k) - x_j^{(0)}(k)\|$$

The symbol ρ is a distinguish coefficient, taken between 0 and 1.0, frequently taken as 0.5.

Definition 4. The grey relational grade is taken as follows:

$$\gamma(x_i^{(0)}(k), x_j^{(0)}(k)) = \sum_{k=1}^m w_k \xi(x_i^{(0)}(k), x_j^{(0)}(k)), \tag{8}$$

$$\sum_{k=1}^m w_k = 1$$

The relational grades are numerical measures of the influence of factors on the objective values, and the numeric values are among 0 and 1. Generally, $\gamma > 0.9$ indicates a marked influence, $\gamma > 0.8$ a relatively marked influence, $\gamma > 0.7$ a noticeable influence, and $\gamma < 0.6$ a negligible influence. [5]

4 Data Analysis and Results

The study started the evaluation of business operation performance with 9 tourist hotels in Taiwan as study objects. To avoid possible trouble or incontinence, let (A_1, A_2, \dots, A_9) represent the 9 tourist hotels. Current ratio (C_1), Fixed assets turnover ratio (C_2), debt ratio (C_3), return on equity (C_4), operating income growth rate (C_5) and account receivable turnover ratio (C_6), the six financial indexes, are to be the evaluating criteria to measure operating performance. Table 2 shows the data and information of financial ratios extracted from the financial statements in 2012 given by the companies and all acquirable in Taiwan Stock Exchange (TWSE).

Systematic approaches of the computational procedures of grey relational analysis are described below:

Step 1. Initialize and transfer the original sequences data

Retrieved from the database, the initial original sequence (set out in Table 2) for these six criteria and 9 tourist hotels can be represented in matrix as:

$$X_0 = \begin{matrix} & C_1 & C_2 & \cdots & C_6 \\ \begin{matrix} A_1 \\ A_2 \\ \vdots \\ A_9 \end{matrix} & \begin{bmatrix} x_1(1) & x_1(2) & \cdots & x_1(6) \\ x_2(1) & x_2(2) & \cdots & x_2(6) \\ \vdots & \vdots & \vdots & \vdots \\ x_9(1) & x_9(2) & \cdots & x_9(6) \end{bmatrix} \end{matrix}$$

The symbol C_1, \dots, C_6 represents the six criteria of evaluation. The values of the original data must be normalized to have the same order, and are commonly normalized by mean value:

$$y_i = \frac{x_i(k)}{\frac{1}{m} \sum_{k=1}^m x_i(k)} \quad m = 9$$

Step 2. Determine the reference sequences and comparability sequences

Values of the reference sequences are the maximum in each criterion listed in Table 3. Reference sequences and comparability sequences are shown as Table 3.

Step 3. Determine the grey relational deviation sequences.

The deviation sequences Δ_{0i} can be defined as:

$$\Delta_{0i} = \left\| x_0^*(k) - x_i^*(k) \right\| \tag{9}$$

All the deviation values of comparability sequences processed by Eq. (9) can be seen in Table 4.

Step 4. Identify the maximum and minimum deviation.

Eq. (10) is adopted to perform the maximum and minimum deviation, Δ_{\max} is the absolute maximum deviation value between $x_0^{(0)}(k)$ and $x_i^{(0)}(k)$, and Δ_{\min} is the absolute minimum deviation value between $x_0^{(0)}(k)$ and $x_i^{(0)}(k)$.

$$\begin{aligned} \Delta_{\max} &= \max |x_0^{(0)}(k) - x_i^{(0)}(k)| \\ \Delta_{\min} &= \min |x_0^{(0)}(k) - x_i^{(0)}(k)| \end{aligned} \tag{10}$$

Investigating the values presented in Table 4, we find that $\Delta_{\max}(k)$ and $\Delta_{\min}(k)$ are taken as follows:

$$\begin{aligned} \Delta_{\max}(k) &= \Delta_{02}(5) = |-2.4204 - 10.6120| = 13.0324 \\ \Delta_{\min}(k) &= \Delta_{04}(1) = |5.9230 - 5.9230| = 0 \end{aligned}$$

Step 5. Produce the grey relational coefficient ξ .

The value of the distinguishing coefficient ρ lies between real numbers 0 and 1, that is, $\rho \in [0,1]$. This study taken it as 0.5.

Table 2. Original sequences data

	C_1	C_2	C_3	C_4	C_5	C_6
x_1	17.00	0.34	30.00	7.22	-4.69	36.00
x_2	63.41	0.36	51.96	-2.10	-12.48	37.51
x_3	159.51	0.42	24.90	3.34	2.27	25.36
x_4	2353.60	0.30	12.50	4.50	4.57	56.80
x_5	54.44	2.70	39.97	34.98	3.07	21.35
x_6	32.69	0.30	39.74	6.21	-6.67	25.78
x_7	427.75	0.53	24.37	5.32	3.67	17.81
x_8	396.56	4.26	11.00	12.40	1.95	103.34
x_9	71.35	0.81	47.63	6.38	54.71	10.48

Table 3. Normalization of original sequences data and comparability sequences

	C_1	C_2	C_3	C_4	C_5	C_6
x_0	5.9230	3.8263	0.3510	4.0233	10.6120	2.7810
x_1	0.0428	0.3054	0.9572	0.8304	-0.9090	0.9688
x_2	0.1596	0.3234	1.6579	-0.2415	-2.4204	1.0094
x_3	0.4014	0.3772	0.7945	0.3842	0.4399	0.6825
x_4	5.9230	0.2695	0.3988	0.5176	0.8859	1.5286
x_5	0.1370	2.4251	1.2753	4.0233	0.5950	0.5746
x_6	0.0823	0.2695	1.2680	0.7142	-1.2945	0.6938
x_7	1.0765	0.4760	0.7776	0.6119	0.7122	0.4793
x_8	0.9980	3.8263	0.3510	1.4262	0.3790	2.7810
x_9	0.1796	0.7275	1.5197	0.7338	10.6120	0.2820

Table 4. Grey relational deviation sequences

	C_1	C_2	C_3	C_4	C_5	C_6
Δ_1	5.8802	3.5210	0.6062	3.1928	11.5210	1.8122
Δ_2	5.7634	3.5030	1.3069	4.2648	13.0324	1.7716
Δ_3	5.5216	3.4491	0.4435	3.6391	10.1721	2.0986
Δ_4	0.0000	3.5569	0.0479	3.5057	9.7261	1.2525
Δ_5	5.7860	1.4012	0.9243	0.0000	10.0169	2.2065
Δ_6	5.8407	3.5569	0.9170	3.3090	11.9064	2.0873
Δ_7	4.8465	3.3503	0.4266	3.4114	9.8997	2.3017
Δ_8	4.9250	0.0000	0.0000	2.5971	10.2330	0.0000
Δ_9	5.7434	3.0988	1.1688	3.2895	0.0000	2.4990

Step 6. Grey relational grade for 9 tourist hotels

Applying the data in Table 4 to the following equation, and calculating grey relational grades of the 9 tourist hotels, where w_k is the weight of each criterion and we set it at 1/6 in this research.

$$\gamma(x_0^{(0)}(k), x_j^{(0)}(k)) = \sum_{k=1}^6 \left[\xi(x_0^{(0)}(k), x_j^{(0)}(k)) \times w_k \right]$$

From Table 5, we prioritize the 9 tourist hotels in accordance with their grey relational degrees. The larger the degree toward the $x_0^{(0)}(k)$ implies the better operation performance of hotel. Therefore, the ascend relational rank for tourist hotels are substituted as follows:

$$\gamma_{08} \succ \gamma_{04} \succ \gamma_{09} \succ \gamma_{05} \succ \gamma_{07} \succ \gamma_{03} \succ \gamma_{01} \succ \gamma_{02}$$

Table 5. Grey relational coefficient computation

	γ_{0i}	C_1	C_2	C_3	C_4	C_5	C_6	Rank
$\xi(x_0(k), x_1(k))$	0.6508	0.5257	0.6492	0.9149	0.6711	0.3613	0.7824	7
$\xi(x_0(k), x_2(k))$	0.6230	0.5307	0.6504	0.8329	0.6044	0.3333	0.7862	9
$\xi(x_0(k), x_3(k))$	0.6533	0.5413	0.6539	0.9363	0.6417	0.3905	0.7564	6
$\xi(x_0(k), x_4(k))$	0.7550	1.0000	0.6469	0.9927	0.6502	0.4012	0.8388	2
$\xi(x_0(k), x_5(k))$	0.7283	0.5297	0.8230	0.8758	1.0000	0.3941	0.7470	4
$\xi(x_0(k), x_6(k))$	0.6375	0.5273	0.6469	0.8766	0.6632	0.3537	0.7574	8
$\xi(x_0(k), x_7(k))$	0.6608	0.5735	0.6604	0.9386	0.6564	0.3969	0.7390	5
$\xi(x_0(k), x_8(k))$	0.7789	0.5695	1.0000	1.0000	0.7150	0.3890	1.0000	1
$\xi(x_0(k), x_9(k))$	0.7407	0.5315	0.6777	0.8479	0.6645	1.0000	0.7228	3

From Table 2, the ranking of performance should be $A_8 > A_4 > A_9 > A_5 > A_7 > A_3 > A_1 > A_2$. Per this study result, A_8 is the best practice of the **9 tourist hotels** in 2012. And the result also can be verified by the fact that the return on equity (C_4) and operating income growth rate of A_9 are both higher than the others, which indicates that the company's profitability is at the top and its operating competency has attained an acceptable level.

The performance result of A_4 is the second only to A_8 . Compared the performances of the two companies in each evaluative indicator from Table 2, the Current ratio (C_1) of A_4 is higher than A_8 and its fixed assets turnover ratio lower, which shows A_4 has been at a certain level in dimensions of solvent capability, while the other indicators all shows A_4 is inferior than A_8 . For the above reasons, it is recommended that the company A_4 make the most of benchmarking to foster the advantages of itself, improve the disadvantages and eventually promote and advance the operating performance of the company.

Moreover, we found the performance result of A_9 is next best to A_4 . Compared the performances of the two companies in each evaluative indicator from Table 2, the return on equity (C_4), operating income growth rate (C_5) of A_9 is higher than A_4 , but its debt ratio is obviously higher than A_4 . This indicates the effectiveness of production and sales of A_9 is feeble and results in less effective in business operating. Also, the great extent of debt is unfavorable to creditors. For the above reasons, the management of the company A_9 is recommended to practice benchmarking to improve the business operating performance.

5 Conclusion

This study is aimed at the 9 tourist hotels in Taiwan and utilizes financial indexes from open resources to analyze; with the application of the method of Grey Relational Analysis, we obtain the grades of performance evaluation and rank them accordingly. The following are conclusions derived from empirical analysis of the study: This study selects appropriate financial indicators to measure operating performance and each corresponds to a certain performance dimension, which gives the measuring more comprehensiveness integrity. The study provides a way to evaluate business operating performance and assists business administration to have a good grasp of the performance discrepancy in the industry. Making good use of benchmarking encourages business competitiveness and benefit operating performance by mutual learning and imitating, adjusting business policies, appropriately allocating business resources and searching out the main factors in such a difference. Therefore, the evaluation results of business operating performance is valuable and of considerable referential importance for both the management of a corporation and the general investors.

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