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資訊服務業之企業聲望排序

Prioritizing the Business Reputation in Information Service Industries

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摘要

本研究使用非常有彈性並且易於使用於決策問題的灰關聯分析，採用不同的參數與權重設定，針對七家資訊服務業進行企業聲望排序。雖然使用不同的參數與權重產生不同的排序結果，不過 IBM 與 Motorola 在資訊服務業當中是最好的兩家企業；其餘的五家企業仍有進步的空間。更重要的是，這四或五家企業的企業聲望之差距可能並不是如此的顯著。

關鍵字：企業聲望、灰關聯分析、排序、權重

Abstract

This study uses grey relational analysis, which is very flexible and ease of use to deal with decision-making problems, to prioritize the business reputation of the seven companies in information service industries with different parameters and weights settings. Though using different parameters and weights could generate different priority, the study has revealed that IBM in Taiwan and Motorola, Inc. in Taiwan were the two best companies in information service industries, whereas the other five companies still have room for improvement. More importantly, the gap in business reputation among the other four or five companies might not be significant.

Keywords: Business reputation, Grey relational analysis, Priority, Weight

1. Introduction

A survey conducted by the Common Wealth magazine in October issue of 2002 has revealed the current enterprises that have better business operations in Taiwan. Twenty major industries, that may have significant impacts in Taiwan economic development, were investigated by the peers of the similar industries and the expertise. Each company was evaluated by the categories of (1) Foresight, (2) Innovation, (3) Customer-oriented product and service quality, (4) Operational performance and organizational effectiveness, (5) Finance

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proficiency, (6) Ability to attracting and training employees, (7) Ability to applying information technologies to be competitive, (8) Internationalization, (9) Value of long-term investment, and (10) Social responsibility (Common Wealth magazine, 2002).

Each index has a highest score of 10 and a lowest score of 1. In addition, the business reputation was computed by the arithmetic average from these ten indices. That is, each index was equally weighted with 0.1. To prioritize the business reputation, any company that has the highest average value is considered to be the best enterprise. For information service industries, seven major companies were surveyed, including International Business Machines (IBM) in Taiwan, Motorola, Inc. in Taiwan, Philips Electronics in Taiwan, Agilent Technologies Taiwan Ltd., Panasonic Industrial Sales (Taiwan) Co., Ltd., Toshiba Electronics in Taiwan, and Samsung Electronics in Taiwan. According to Table 1, IBM performed the best, and Motorola was in second, while Samsung Electronics was the last.

Table 1 The Original Data for Each Company from the Common Wealth Magazine

	Average	Category									
		1	2	3	4	5	6	7	8	9	10
IBM	7.30	7.25	7.01	7.14	7.07	7.24	7.58	7.74	7.96	7.34	6.65
Motorola	7.24	7.28	7.36	7.02	6.99	7.17	7.21	7.73	7.97	7.17	6.55
Philips Electronics	7.03	7.04	6.98	6.9	6.7	6.92	7.04	7.25	7.67	7.1	6.68
Agilent Technologies	6.79	6.57	6.83	6.63	6.63	6.76	6.84	7.13	7.35	6.98	7.23
Panasonic Industrial Sales Co.	6.78	6.61	6.65	6.75	6.53	6.95	6.6	7.04	7.43	6.82	6.4
Toshiba Electronics	6.67	6.6	6.58	6.72	6.38	6.78	6.69	7.01	7.19	6.57	6.21
Samsung Electronics	6.60	6.66	6.81	6.51	6.67	6.63	6.28	6.98	7.18	6.6	5.72

The survey also provided the importance of each index by the peers of the similar industries and the expertise, as depicted in Table 2. However, the weights were not taken into account when the business reputation was evaluated and compared. Since each index was weighted differently, the evaluation with the weights might provide different viewpoints. On the other hand, the philosophy of benchmark focuses on the comparison with the best enterprises in the same or even similar industries and is a way to determine an organization's potential for improvement. In this study, the philosophy of benchmark is applied by selecting the highest score from each category.

Table 2 The Importance of Each Index

Index	Original Importance	Normalized Weight
Foresight	2984	0.2947 (2984/10126)
Innovation	2151	0.2124 (2151/10126)
Customer-oriented product and service quality	1394	0.1377 (1394/10126)
Operational performance and organizational effectiveness	1039	0.1026 (1039/10126)
Finance proficiency	637	0.0629 (637/10126)
Ability to attracting and training employees	696	0.0687 (696/10126)
Ability to applying information technologies to be competitive	325	0.0321 (325/10126)
Internationalization	557	0.0550 (557/10126)
Value of long-term investment	176	0.0174 (176/10126)
Social responsibility	167	0.0165 (167/10126)
Sum	10126	1.0000

To address the above discussions and provide different viewpoints, this study will use grey relational analysis (GRA) as a tool to evaluate the business reputation because of its ease of use in decision-making processes. Finally, this study will describe the differences with the consideration of both equal and unequal weights.

2. Grey Relational Analysis

Grey theory, originally developed by Deng, has been widely applied to solve the uncertainty problems under the discrete data and incomplete information (Deng, 1982, 1989; Lin and Lin, 2001; Kuo and Wu, 2003). Besides, grey relational analysis is one of the very popular methods to analyze various relationships among the discrete data sets and make decisions in multiple attribute situations (Tzeng and Tasur, 1994; Peng and Kirk, 1999; Chiou and Tzeng, 2001; Kuo and Wu, 2001, 2003; Wu, 2002, 2002-03; Lin and Ho, 2003). The characteristics of grey relational analysis are as follows: The results are computed and analyzed based upon the original data, and the calculations are simple and straightforward. Moreover, it is one of the best methods to make decisions under business environment (Wu, 2002, 2002-03). The procedures of GRA are summarized as follows (Wu, 2002, 2002-03; Kuo and Wu, 2003):

Step 1: Define and generate the referential series of x_0 = (x_0 (1), x_0 (2), x_0 (3),…, x_0 (k),…, x_0 (n)) with k entities, where k = 1,2,3,…,n, and x_i is the compared series of (x_i (1), x_i (2), x_i (3),…, x_i (k),…, x_i (n)), where i = 1,2,3,…,m.

Step 2: Normalize the data set. Data can be transformed by one of the three types, i.e., the larger-is-better transformation, the smaller-is-better transformation, and the nominal-is-best transformation.

For the larger-is-better transformation, the formula of normalizing $x_i(k)$ to $x_i^*(k)$ is

$$x_i^*(k) = \frac{x_i(k) - \min_k x_i(k)}{\max_k x_i(k) - \min_k x_i(k)}, \tag{1}$$

where $\max_k x_i(k)$ and $\min_k x_i(k)$ are the maximum and minimum values of entity *k*. For the smaller-is-better transformation, Equation (2) is used to transform $x_i(k)$ to $x_i^*(k)$:

$$x_i^*(k) = \frac{\max_k x_i(k) - x_i(k)}{\max_k x_i(k) - \min_k x_i(k)}. \tag{2}$$

For the nominal-is-best transformation, if the target value is $x_{0b}(k)$ and $\max_k x_i(k) \geq x_{0b}(k) \geq \min_k x_i(k)$, then the equation is

$$x_i^*(k) = \frac{|x_i(k) - x_{0b}(k)|}{\max_k x_i(k) - x_{0b}(k)}. \tag{3}$$

On the other hand, the referential series of x_0 should also be normalized as well by one of Equations (2)-(4). In this case, $x_0(k)$ is used to replace $x_i(k)$. Therefore, the normalized referential series becomes $x_0^* = (x_0^*(1), x_0^*(2), x_0^*(3), \ldots, x_0^*(k), \ldots, x_0^*(n))$.

Step 3: Compute the distance of $\Delta_{0i}(k)$, which is the absolute value of difference between x_0^* and x_i^* at the *k*-th point. The mathematical expression is as follows:

$$\Delta_{0i}(k) = |x_0^*(k) - x_i^*(k)|. \tag{4}$$

Step 4: Apply grey relational equation to compute grey relational coefficient $r_{0i}(k)$:

$$\gamma_{0i}(k) = \frac{\Delta\min + \zeta\Delta\max}{\Delta_{0i}(k) + \zeta\Delta\max}, \tag{5}$$

where $\Delta\max = \max_i \max_k \Delta_{0i}(k)$, $\Delta\min = \min_i \min_k \Delta_{0i}(k)$, and $\zeta \in [0,1]$. Typically, ζ is set to 0.5.

Step 5: Compute the degree of grey coefficient Γ_{0i}. If the weights (W_i) of criteria are determined and normalized, i.e., $\sum_{i=1}^{n} W_i = 1$, Γ_{0i} becomes

$$\Gamma_{0i} = \sum_{k=1}^{n} [W_i(k) \times r_{0i}(k)]. \quad (6)$$

The computed Γ_{0i} values in Equation (6) are compared and prioritized. An alternative with the highest Γ_{0i} value is to be the most important alternative, while the alternative with the lowest Γ_{0i} value is viewed as the least important alternative. The entire alternatives can be ranked in accordance with Γ_{0i} values.

3. The Analysis

To apply GRA in business reputation, the first step is to define and generate the referential series, where the highest scores from these seven companies (i = 1,2,3,…,7) in the ten categories (k = 1,2,3,…,10) are defined as the referential series, i.e., x_0 = (7.28, 7.36, 7.14, 7.07, 7.24, 7.58, 7.74, 7.97, 7.34, 7.23). The next step is to normalize the data sets in Table 1, where each row represents the alternative, while the column means the criterion used to evaluate for each alternative. Since a higher value represents the better condition, the larger-is-better transformation of Equation (1) is applied. The values of $\max_k x_i(k)$ and $\min_k x_i(k)$, where k = 1,2,3,…,10, are the highest and lowest scores from these ten indices. For instance, when k = 5, $\max_5 x_i(5)$ and $\min_5 x_i(5)$ are 7.24 and 6.63, respectively. The transformed data along with the normalized referential series are presented in Table 3.

Table 3 The Normalized Data Sets Using the Larger-is-Better Transformation

	Category									
	1	2	3	4	5	6	7	8	9	10
Referential Series	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
IBM	0.9577	0.5513	1.0000	1.0000	1.0000	1.0000	1.0000	0.9873	1.0000	0.6159
Motorola	1.0000	1.0000	0.8095	0.8841	0.8852	0.7154	0.9868	1.0000	0.7792	0.5497
Philips Electronics	0.6620	0.5128	0.6190	0.4638	0.4754	0.5846	0.3553	0.6203	0.6883	0.6358
Agilent Technologies	0.0000	0.3205	0.1905	0.3623	0.2131	0.4308	0.1974	0.2152	0.5325	1.0000
Panasonic Industrial Sales Co.	0.0563	0.0897	0.3810	0.2174	0.5246	0.2462	0.0789	0.3165	0.3247	0.4503
Toshiba Electronics	0.0423	0.0000	0.3333	0.0000	0.2459	0.3154	0.0395	0.0127	0.0000	0.3245
Samsung Electronics	0.1268	0.2949	0.0000	0.4203	0.0000	0.0000	0.0000	0.0000	0.0390	0.0000

The third step is to ccompute $\Delta_{0i}(k)$, the absolute value of difference between x_0^* and x_i^* at the k-th point. By applying Equation (4), the outcomes are summarized in Table 4. The fourth step is to use Equation (5) to compute $r_{0i}(k)$, where $\Delta\max = \max_i \max_k \Delta_{0i}(k)$ = 1.0000 and $\Delta\min = \min_i \min_k \Delta_{0i}(k)$ = 0. To simplify the computation, the results of ζ = 1.0 are described in Table 5. Table 6 summarizes the numerical comparison with both equal weights (0.1 for each index) and unequal but normalized weights (using Table 2), where the number in the square bracket is the priority.

Table 4 The Numerical Results of Computing the Distance of $\Delta_{0i}(k)$

	Category									
	1	2	3	4	5	6	7	8	9	10
IBM	0.0423	0.4487	0.0000	0.0000	0.0000	0.0000	0.0000	0.0127	0.0000	0.3841
Motorola	0.0000	0.0000	0.1905	0.1159	0.1148	0.2846	0.0132	0.0000	0.2208	0.4503
Philips Electronics	0.3380	0.4872	0.3810	0.5362	0.5246	0.4154	0.6447	0.3797	0.3117	0.3642
Agilent Technologies	1.0000	0.6795	0.8095	0.6377	0.7869	0.5692	0.8026	0.7848	0.4675	0.0000
Panasonic Industrial Sales Co.	0.9437	0.9103	0.6190	0.7826	0.4754	0.7538	0.9211	0.6835	0.6753	0.5497
Toshiba Electronics	0.9577	1.0000	0.6667	1.0000	0.7541	0.6846	0.9605	0.9873	1.0000	0.6755
Samsung Electronics	0.8732	0.7051	1.0000	0.5797	1.0000	1.0000	1.0000	1.0000	0.9610	1.0000

Table 5 The Numerical Results of Computing Grey Relational Coefficient $r_{0i}(k)$

	Category									
	1	2	3	4	5	6	7	8	9	10
IBM	0.9595	0.6903	1.0000	1.0000	1.0000	1.0000	1.0000	0.9875	1.0000	0.7225
Motorola	1.0000	1.0000	0.8400	0.8961	0.8971	0.7784	0.9870	1.0000	0.8191	0.6895
Philips Electronics	0.7474	0.6724	0.7241	0.6509	0.6559	0.7065	0.6080	0.7248	0.7624	0.7330
Agilent Technologies	0.5000	0.5954	0.5526	0.6106	0.5596	0.6373	0.5547	0.5603	0.6814	1.0000
Panasonic Industrial Sales Co.	0.5145	0.5235	0.6176	0.5610	0.6778	0.5702	0.5205	0.5940	0.5969	0.6453
Toshiba Electronics	0.5108	0.5000	0.6000	0.5000	0.5701	0.5936	0.5101	0.5032	0.5000	0.5968
Samsung Electronics	0.5338	0.5865	0.5000	0.6330	0.5000	0.5000	0.5000	0.5000	0.5099	0.5000

Table 6 The Degree of Grey Coefficient Γ_{0i} for Both Equal Weights and Unequal Weights

Company	Equal Weights	Unequal Weights
IBM	0.9360 [1]	0.9170 [2]
Motorola	0.8907 [2]	0.9369 [1]
Philips Electronics	0.6985 [3]	0.7041 [3]
Agilent Technologies	0.6252 [4]	0.5685 [4]
Panasonic Industrial Sales Co.	0.5821 [5]	0.5576 [5]
Toshiba Electronics	0.5385 [6]	0.5299 [7]
Samsung Electronics	0.5263 [7]	0.5422 [6]

Obviously, the priorities in Table 6 are somewhat different if the weights are taken into consideration. For instance, IBM and Motorola could be the top priority, while Toshiba Electronics and Samsung Electronics could be ranked the last depending upon the use of the weights. If different ζ values (from 0.1 to 1.0 with 0.1 increase each time) are further used for analysis, the priorities are somewhat different. Table 7 illustrates the numerical results with different ζ values with equal weights, and Figure 1 shows the pictorial comparison among these seven companies. The priorities are almost identical except for ζ = 0.1. When ζ = 0.1, Philips Electronics was at the fourth spot, while Agilent Technologies was at third. When ζ becomes 0.2 to 1.0, Philips Electronics moves ahead of Agilent Technologies.

Table 7 The Numerical Results with Different ζ Values with Equal Weights.

ζ Values	0.1	0.2	0.3	0.4	0.5
IBM	0.7979	0.8417	0.8675	0.8855	0.8990
Motorola	0.5910	0.6914	0.7503	0.7897	0.8181
Philips Electronics	0.1919	0.3207	0.4135	0.4837	0.5387
Agilent Technologies	0.2127	0.2996	0.3688	0.4253	0.4724
Panasonic Industrial Sales Co.	0.1247	0.2209	0.2976	0.3602	0.4125
Toshiba Electronics	0.1057	0.1908	0.2609	0.3196	0.3696
Samsung Electronics	0.1014	0.1836	0.2518	0.3093	0.3584
ζ Values	0.6	0.7	0.8	0.9	1.0
IBM	0.9095	0.9180	0.9251	0.9309	0.9360
Motorola	0.8396	0.8564	0.8701	0.8813	0.8907
Philips Electronics	0.5830	0.6196	0.6501	0.6762	0.6985
Agilent Technologies	0.5123	0.5465	0.5762	0.6022	0.6252
Panasonic Industrial Sales Co.	0.4568	0.4947	0.5277	0.5566	0.5821
Toshiba Electronics	0.4127	0.4502	0.4832	0.5124	0.5385
Samsung Electronics	0.4010	0.4382	0.4710	0.5002	0.5263

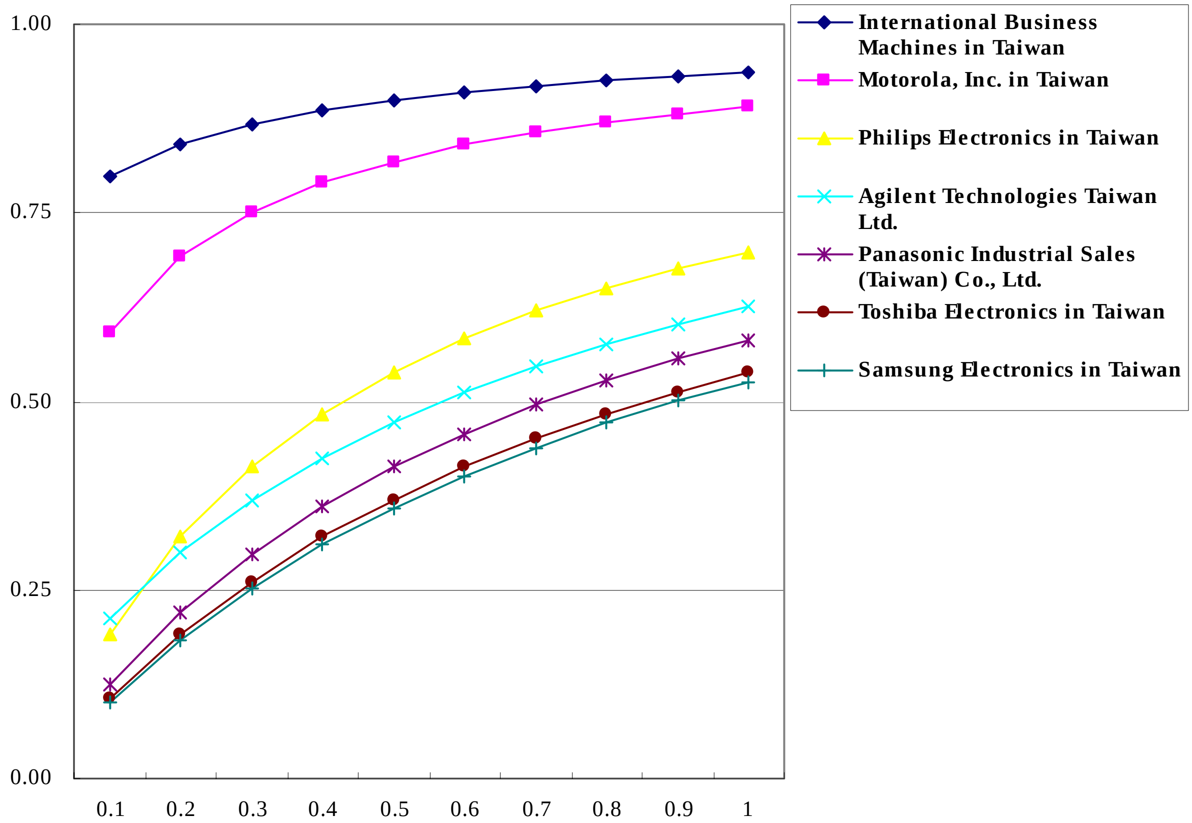

Figure 1 The Graphical Presentation of the Seven Companies with Equal Weights in Business Reputation

Table 8 summarizes the numerical results with different ζ values when unequal weights are considered, while Figure 2 provides graphical presentation. Using different ζ values does not change the business reputation of the seven companies. However, Table 8 provides different scenario than Table 7, where Motorola always outperformed IBM, and Samsung Electronics was slight better than Toshiba Electronics in business reputation.

Table 8 The Numerical Results with Different ζ Values with Unequal Weights.

ζ Values	0.1	0.2	0.3	0.4	0.5
IBM	0.7195	0.7875	0.8248	0.8498	0.8680
Motorola	0.7410	0.8094	0.8485	0.8740	0.8921
Philips Electronics	0.1952	0.3256	0.4191	0.4897	0.5448
Agilent Technologies	0.1298	0.2191	0.2914	0.3513	0.4017
Panasonic Industrial Sales Co.	0.1140	0.2039	0.2768	0.3373	0.3883
Toshiba Electronics	0.1024	0.1854	0.2541	0.3120	0.3615
Samsung Electronics	0.1073	0.1933	0.2639	0.3230	0.3732
ζ Values	0.6	0.7	0.8	0.9	1.0
IBM	0.8821	0.8934	0.9027	0.9104	0.9170

Motorola	0.9056	0.9160	0.9244	0.9312	0.9369
Philips Electronics	0.5891	0.6256	0.6560	0.6819	0.7041
Agilent Technologies	0.4448	0.4820	0.5145	0.5431	0.5685
Panasonic Industrial Sales Co.	0.4319	0.4697	0.5027	0.5318	0.5576
Toshiba Electronics	0.4042	0.4416	0.4745	0.5037	0.5299
Samsung Electronics	0.4164	0.4539	0.4869	0.5161	0.5422

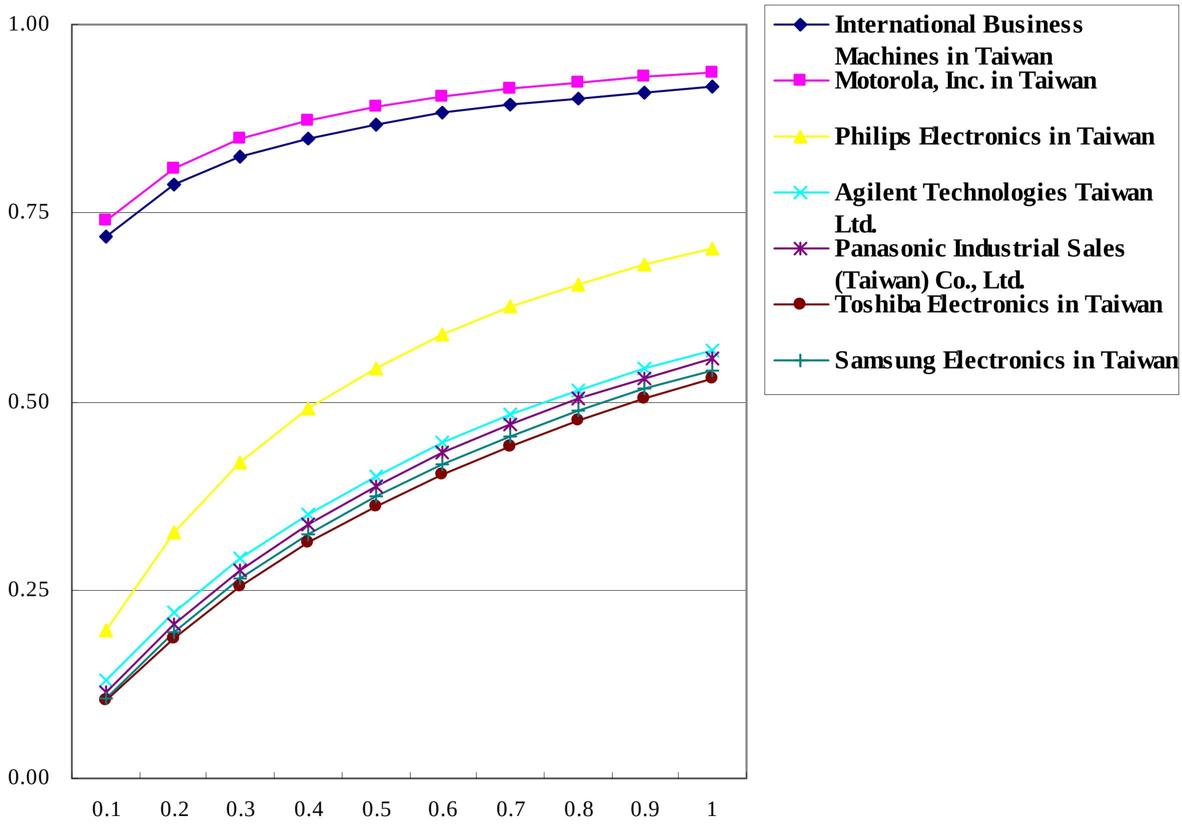

Figure 2 The Graphical Presentation of the Seven Companies with Unequal Weights in Business Reputation

With equal weights as depicted in Figure 1, using larger ζ values seems to shorten the gap between IBM and Motorola but IBM was still the best in business reputation. In contrast to Figure 1, Figure 2 implies that three tiers were formed in business reputation. The first tier consisted of IBM and Motorola, and both of them were very close though Motorola edged IBM. Philips Electronics was solely in the second tier, while the other four companies were in the third tier, which were extremely close graphically no matter what ζ value is. In summary, weights are critically important to determine the business reputation in this case. Moreover, both IBM and Motorola could be the benchmark for the other five companies for improvement.

4. Conclusions

This study shows that grey relational analysis is very flexible and ease of use to deal with decision-making problems by discussing and analyzing the business reputation of the seven companies in information service industries under a variety of criteria. With different weights and/or parameters, the priorities are different. That is, each decision maker can apply different parameters based upon his or her preference. Generally, IBM and Motorola were still the two best companies, whereas the other five companies still have room for improvement.

It is worth to note that the focus of this study is to apply grey relational analysis solely. However, several other methods, such as fuzzy theory, technique for order preference by similarity to ideal solution, weighted product method, to name a few, can be further applied to this data set. Different approaches could generate different results even when the same data set is used. Therefore, a further study can be conducted to evaluate and compare the results by a variety of methods.

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